Limnological Assessment

White Lake
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Prepared for:
White Lake Citizens League
White Lake Improvement Board

Prepared by:
Progressive AE
1811 4 Mile Road, NE
Grand Rapids, MI 49525-2442
616/361-2664

February 2019

Project No: 83300001

progressive|ae

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

Introduction

White Lake is located in Sections 12 and 13 of Highland Township and 7 and 18 of White Lake Township in Oakland County, Michigan (T.3N; R.7-8E; Figure 1). In May of 2018, Progressive AE was retained by the White Lake Citizens League to conduct an assessment of the physical, chemical, and biological characteristics of White Lake. As part of the assessment, historical water quality and fisheries data were compiled and reviewed, and an assessment was made of current lake conditions and management practices. These data will help inform and guide future management decisions on White Lake. This report contains a summary of findings, conclusions and recommendations.

The White Lake Improvement Board was established in the 1980s in accordance with Part 309, Inland Lake Improvements, of Michigan's Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended. Lake management activities on White Lake are funded through special assessment of benefitting properties under provisions of Part 309. The special assessment district for White Lake includes all properties bordering the lake and back lots with deeded lake access. The White Lake Citizens League works closely with the White Lake Improvement Board in an advisory capacity. Past improvements have included a spot-dredging project to improve navigation on the lake and an ongoing aquatic plant control program.

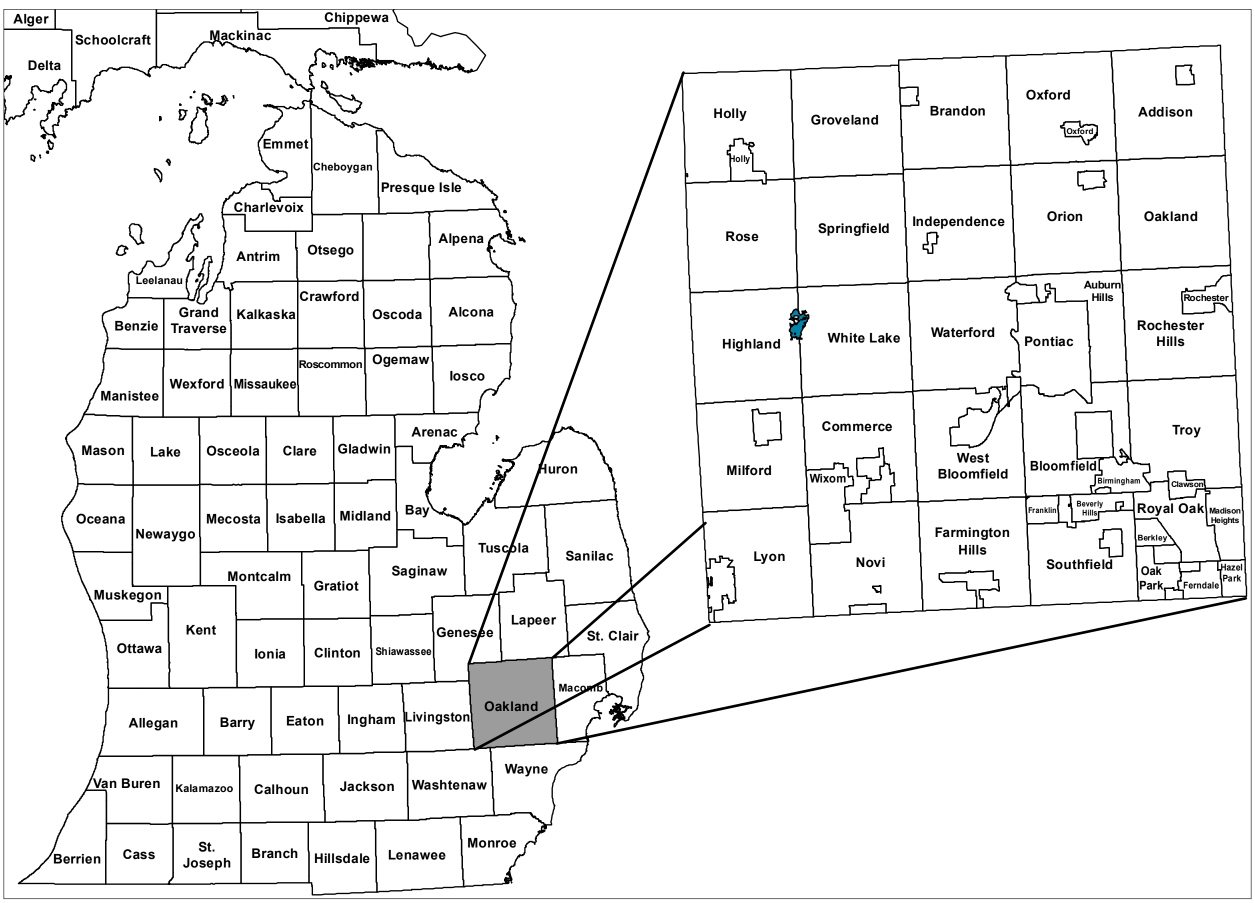


Figure 1. White Lake location map.

Limnology

Limnology is the study of the physical, chemical, and biological characteristics of a lake (Figure 2). Many of Michigan's lakes were formed thousands of years ago when glaciers scraped the landscape. The size and shape of the water-filled holes left behind by the glaciers often determines a lake's physical characteristics.

Lakes can be large or small, deep or shallow, round or convoluted. Size and shape can greatly impact a lake's chemical and biological characteristics. Lake water chemistry can also be influenced by conditions outside of the lake, that is, in the lake's watershed. Given the wide array of physical and chemical conditions that can occur in a lake, a variety of plants and animals have adapted to living in lake environments. As such, each lake contains a unique combination of limnological characteristics. A primary focus of this study is to evaluate the current limnological characteristics of White Lake.

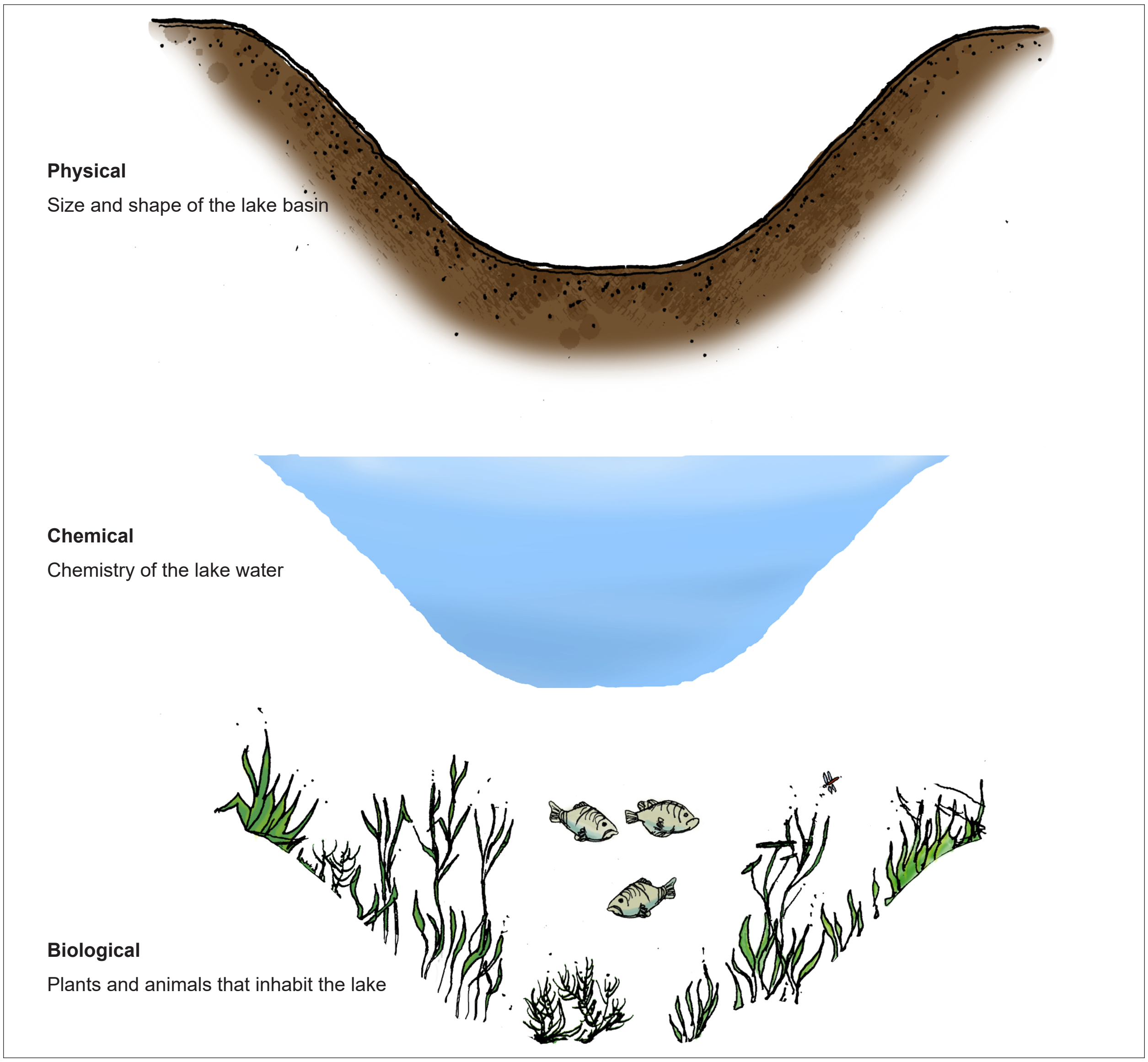


Figure 2. Limnological characteristics of a lake.

Results and Discussion

LAKE AND WATERSHED PHYSICAL CHARACTERISTICS

White Lake was originally mapped by the Michigan Conservation Department Institute of Fisheries Research in May of 1953 (Figure 3). The original mapping indicates White Lake is a relatively large, shallow lake with a long, convoluted shoreline. The original map showed a surface area of 540 acres, a maximum depth of 32 feet in the south basin and 18 feet in the north basin. At the time of mapping, submersed vegetation was present throughout much of the north basin of the lake and the west shore of the south basin.

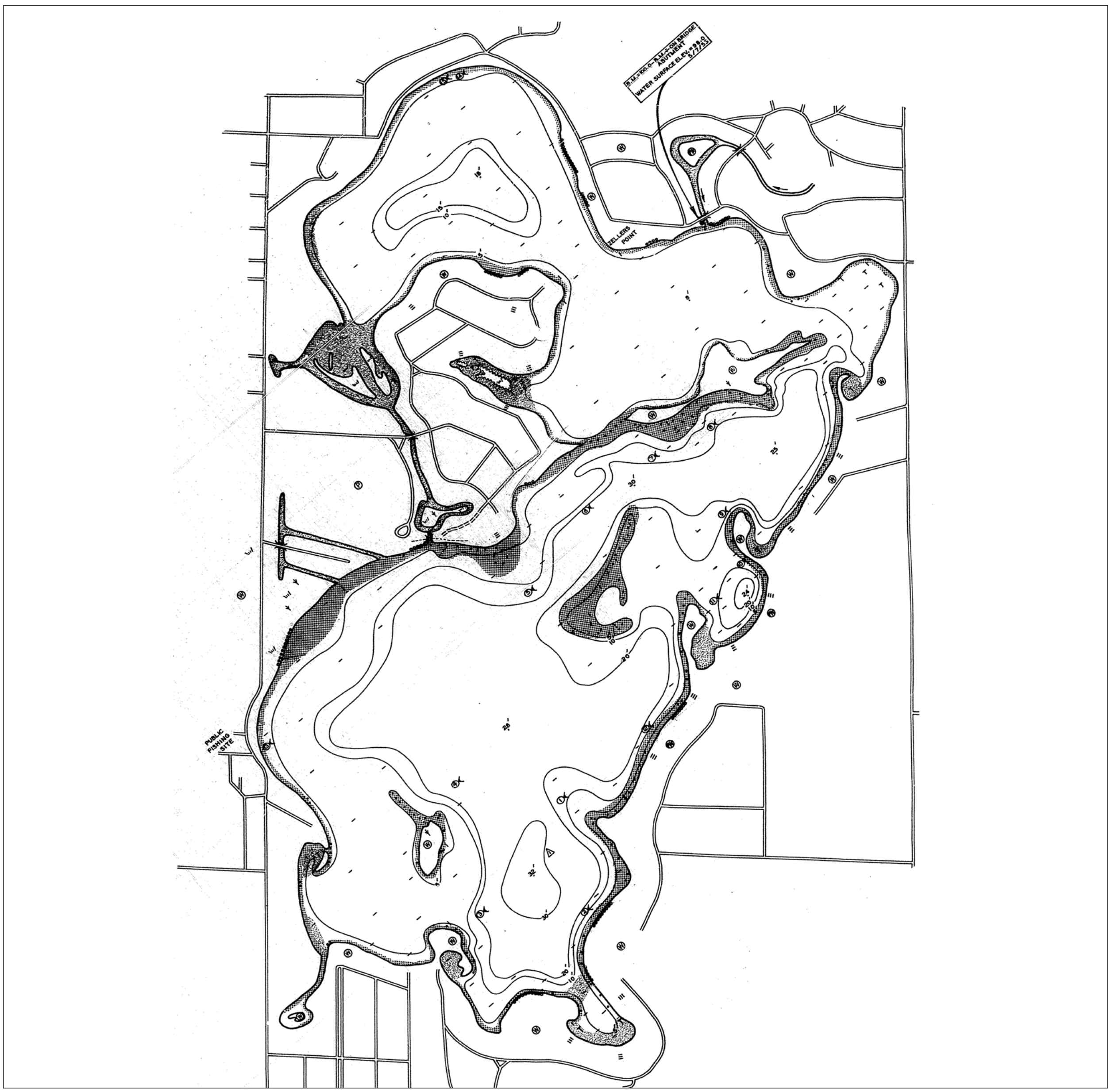


Figure 3. White Lake 1953 depth contour map. Source: Michigan Conservation Department.

In 1964, legal winter and summer levels of 1018.6 and 1019.10 feet above mean sea level respectively were established for White Lake by Circuit Court Order. Shortly thereafter, an augmentation well was constructed to help maintain the legal lake level. Water drains from White Lake to Duck Lake. From Duck Lake, water flows into Pettibone Creek and on to the Huron River and eventually into Lake Erie. There is an approximate 450-foot drop in elevation between White Lake and Lake Erie.

During the course of study, hydro-acoustic soundings of White Lake were taken, and a new depth contour map was created (Appendix A, Figure 4). In comparing the original 1953 map to the new map, the overall depth and configuration of White Lake have remained largely unchanged. The maximum depths in the deeper basins of the lake are nearly identical to those measured in 1953. These data suggest that there has been little fill-in of the main body of the lake since the lake was first mapped 65 years ago. In the more recent mapping, orthodigital photography was used to delineate the shoreline and the lake surface area measured 577 acres. The surface area of White Lake on the original 1953 map was 540 acres.

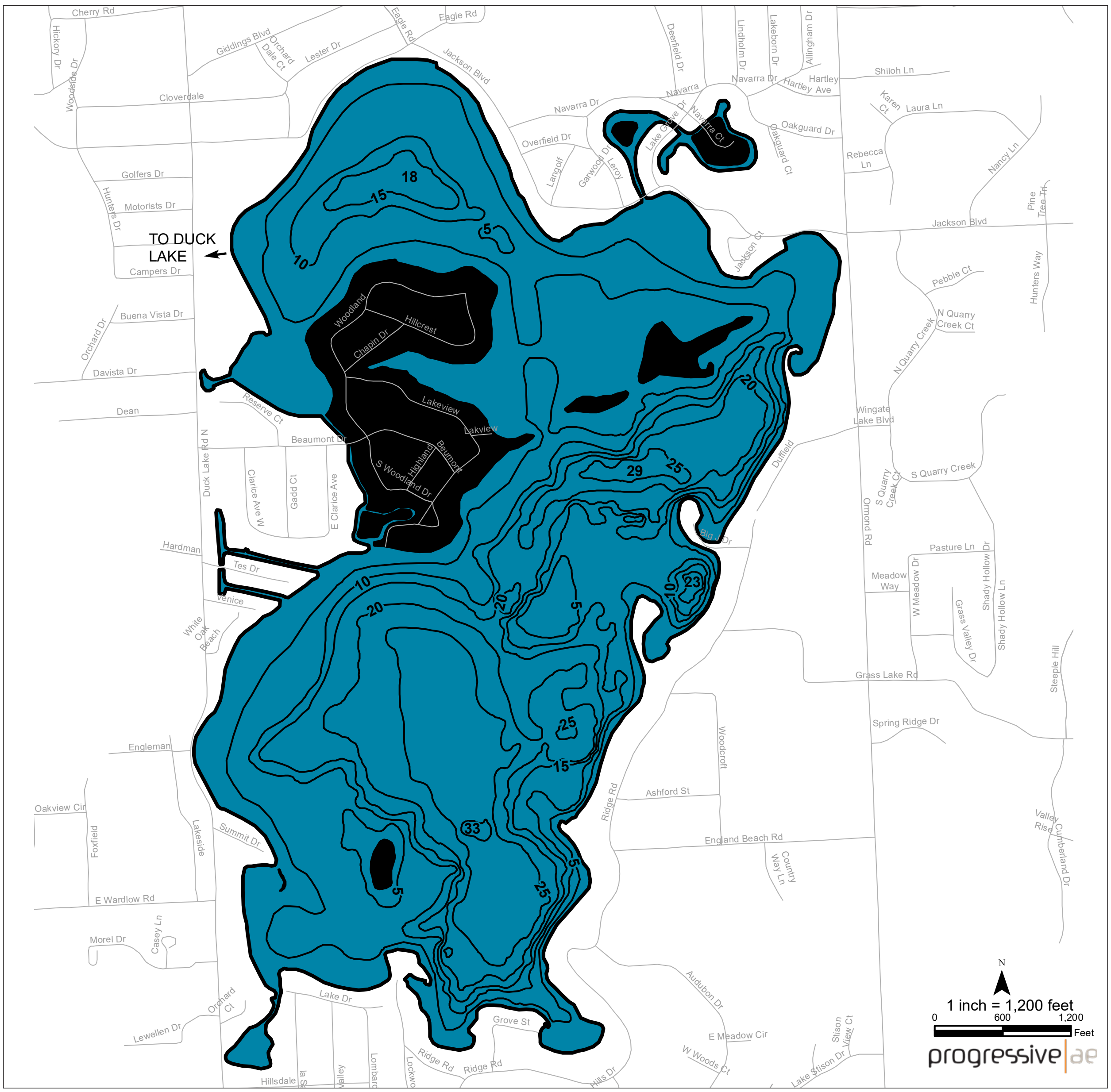


Figure 4. White Lake 2018 depth contour map. Hydro-acoustic depth measurements conducted on July 25, 2018. Lake at legal summer level of 1019.1 feet above sea level at time of survey. Bathymetric data processed by C-MAP. Lake shoreline digitized from aerial orthodigital photography (Source: SEMCOG 2015).

RESULTS AND DISCUSSION

A summary of the physical characteristics of White Lake based on the new mapping is provided in Table 1. According to information available from Michigan's GIS database, White Lake is in the top two percent of Michigan inland lakes by surface area. The mean or average depth of White Lake is 10.6 feet. Since aquatic plants generally grow to a depth of about 15 feet, a significant portion of White Lake is shallow enough to support aquatic plant growth. However, depths in White Lake are sufficient to allow navigation throughout most of the lake. White Lake contains 2.2 billion gallons or 6,090 acre-feet of water, a volume which would cover a land area of over 9.5 square miles to a depth of one foot.

TABLE 1
WHITE LAKE PHYSICAL CHARACTERISTICS

Lake Surface Area	577	acres
State Ranking for Surface Area	211	
Maximum Depth	33	feet
Mean Depth	10.6	feet
Lake Volume	6,090	acre-feet
Shoreline Length	12.3	miles
Shoreline Development Factor	3.7	
Shallowness Factor	0.3	
Legal Lake Level Summer	1,019.1	Feet above sea level
Legal Lake Level Winter	1,018.6	Feet above sea level

Shoreline development factor is a measure of the irregularity of the shoreline. A lake with a perfectly circular shoreline would have a shoreline development factor of 1.0. Shoreline development factor increases as the shoreline becomes more convoluted. In Michigan, shoreline development factor ranges from 1.0 to 13.5 (Figure 5). The lakes with the highest shoreline development factors are usually impoundments, i.e., reservoirs. Shoreline development factor is significant because lakes with more irregular shorelines can accommodate more buildings and other development, which can lead to greater pollution runoff and lake overcrowding. In addition, more convoluted shorelines can support more aquatic plant growth. Wagner (1991) noted:

> The ratio of the length of shoreline around the lake to the circumference of a circle with the same area as the lake [shoreline development factor] provides a size-independent measure of the lake shape and indicates much about how motorized watercraft could affect the water body. Higher ratios suggest irregular shorelines with more waterfront per unit area than smaller ratios. Numerous coves may serve to isolate impacts, but there is a greater potential for the shoreline to be affected. High ratios also imply greater safety risks as well as ecological consequences.

White Lake has a shoreline development factor of 3.7. That is, White Lake's shoreline is 3.7 times longer than if the lake was perfectly round.

The shallowness ratio compares the area of the lake less than 5 feet deep to the total lake area and indicates the degree to which the lake bottom area is likely to be directly affected by motorized watercraft. Impacts of primary concern include sediment suspension, turbidity, and destruction of fish habitat. Shallowness ratios range from low (less than 0.1) for lakes unlikely to be impacted to high (greater than 0.5) for lakes with a high potential for impact. White Lake has a shallowness ratio of 0.3 which indicates that the potential impact of motorized watercraft on the lake is moderate.

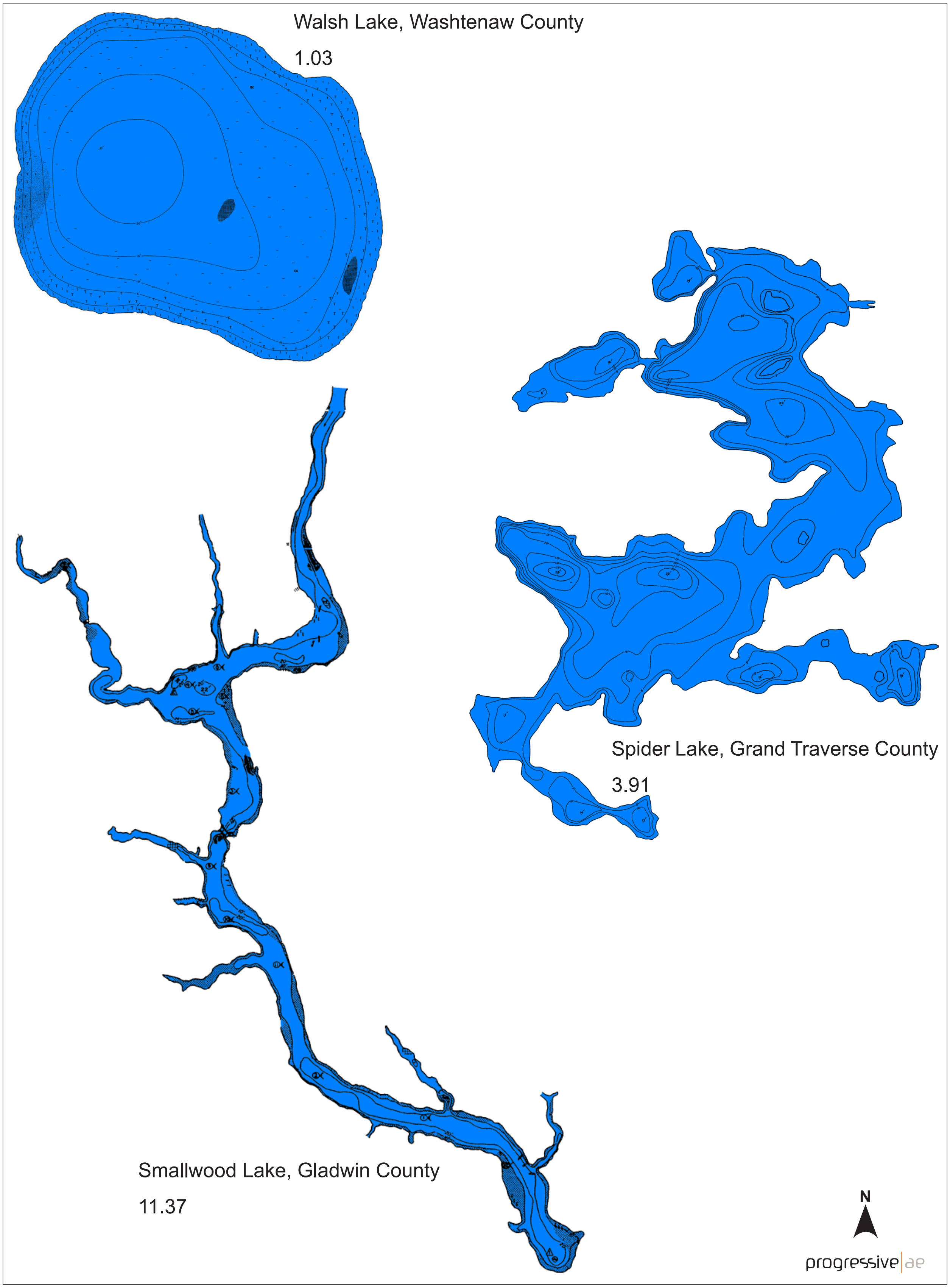


Figure 5. Shoreline development factor of select Michigan inland lakes. Base maps prepared by Michigan Department of Natural Resources, or predecessor agencies. Shoreline development factor calculations based on surface area and shoreline length data from Michigan GIS Open Data.

The land area surrounding a lake that drains to the lake is called its watershed or drainage basin. The White Lake watershed is 3,482 acres or about 5.4 square miles (Figure 6), a land area 6 times larger than the lake. There are no tributary streams that drain to White Lake; and lake levels appear to be sustained primarily by direct precipitation on the lake surface, overland runoff and groundwater. The hydraulic residence time of White Lake (i.e., the time it takes the entire volume of water in White Lake to be replaced by incoming waters) is estimated to be about two years. The White Lake watershed is the headwater area of the larger Huron River watershed.

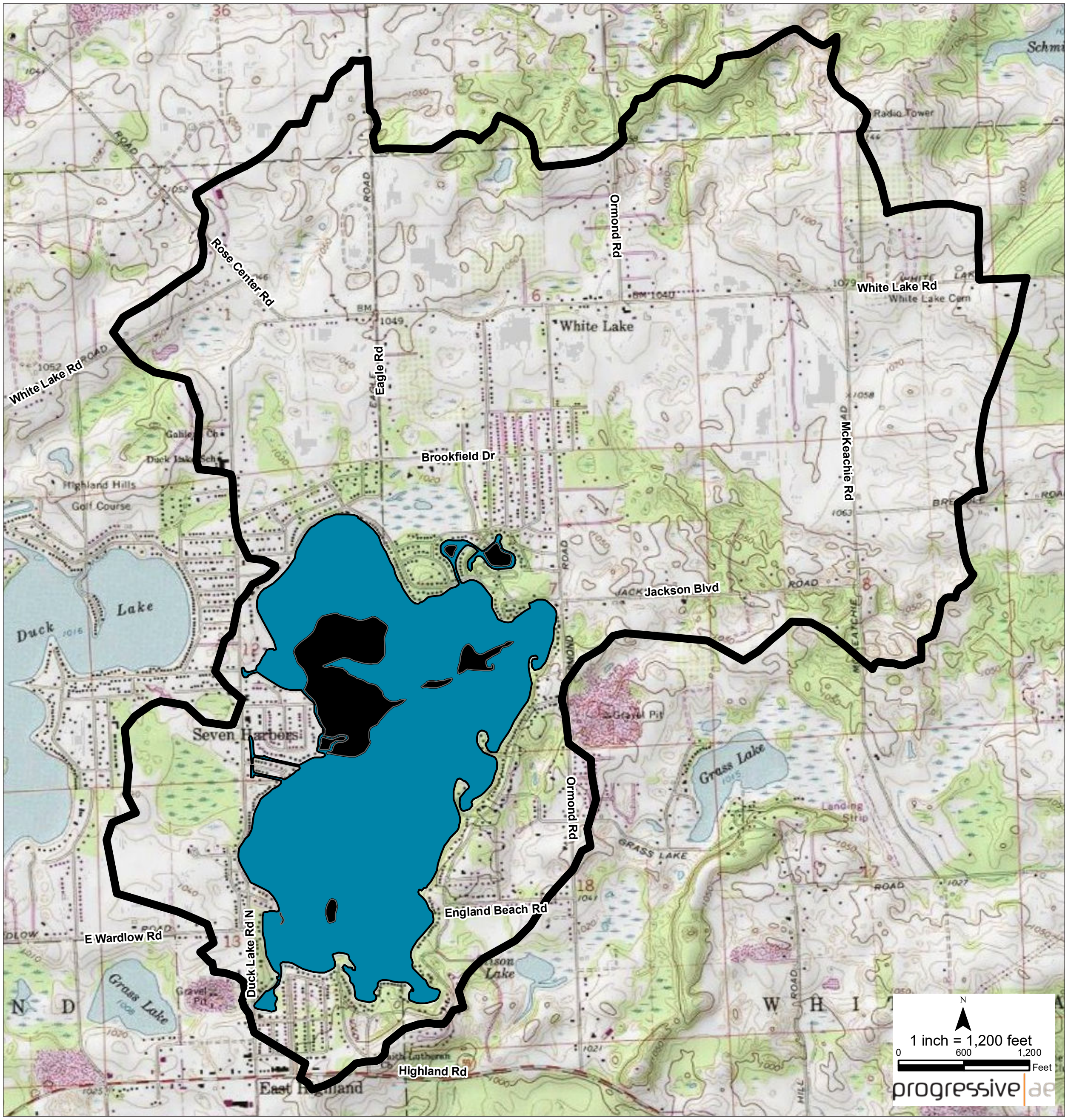


Figure 6. White Lake watershed. Base map: US Geological Survey (Highland quadrangle 1983).

LAKE WATER QUALITY

Lake water quality is determined by a unique combination of processes that occur both within and outside of the lake. In order to make sound management decisions, it is necessary to have an understanding of the current physical, chemical, and biological condition of the lake, and the potential impact of drainage from the surrounding watershed.

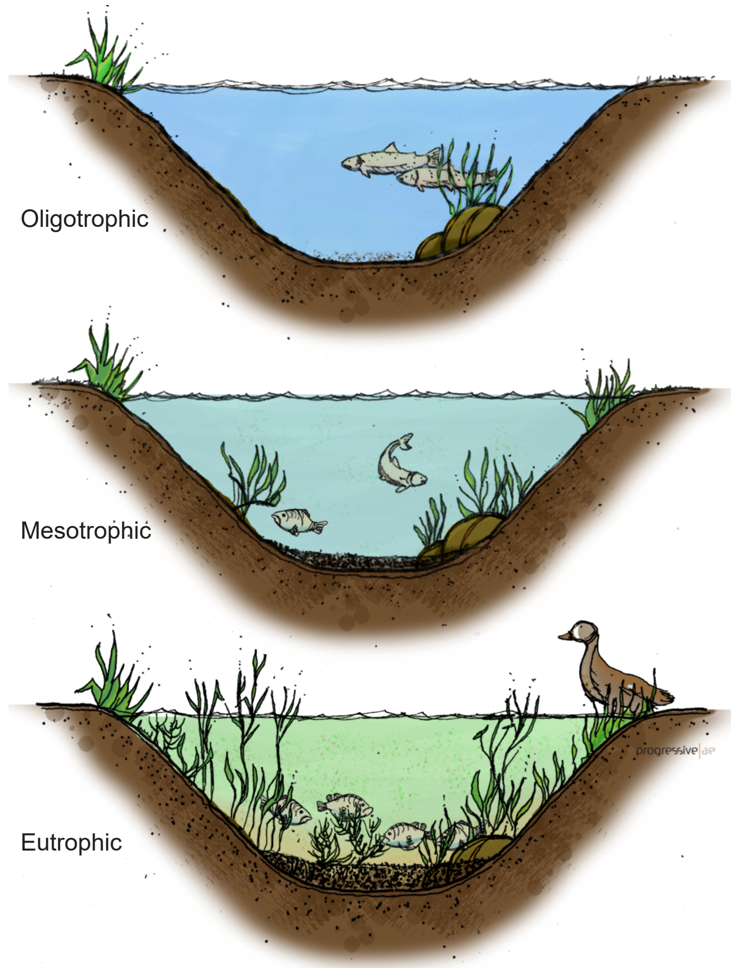


Figure 7. Lake classification.

Scientists classify lakes as **oligotrophic**, **mesotrophic**, or **eutrophic** (Figure 7). Oligotrophic lakes are generally deep and clear with little aquatic plant growth. These lakes maintain sufficient dissolved oxygen in the cool, deep bottom waters during late summer to support cold water fish such as trout and whitefish. By contrast, eutrophic lakes are generally shallow, turbid, and support abundant aquatic plant growth. In deep eutrophic lakes, the cool bottom waters usually contain little or no dissolved oxygen. Therefore, these lakes can only support warm water fish such as bass and pike. Lakes that fall between these two extremes are called mesotrophic lakes. In a recent assessment of Michigan's lakes, the U.S. Geological Survey estimated that statewide about 25% of lakes are oligotrophic, 52% are mesotrophic and 23% are eutrophic (Fuller and Taricska 2012).

Under natural conditions, most lakes will ultimately evolve to a eutrophic state as they gradually fill with sediment and organic matter transported to the lake from the surrounding watershed. As the lake becomes shallower, the process accelerates. When aquatic plants become abundant, the lake slowly begins to fill in as sediment and decaying plant matter accumulate on the lake bottom. Eventually, terrestrial plants become established and the lake is transformed to a marshland. The aging process in lakes is called "eutrophication" and may take anywhere from a few hundred to several thousand years, generally depending on the size of the lake and its watershed. The natural lake aging process can be greatly accelerated if excessive amounts of sediment and nutrients (which stimulate aquatic plant growth) enter the lake from the surrounding watershed. Thus, in developing a management plan, it is necessary to determine the limnological (i.e., the physical, chemical, and biological) condition of the lake and the physical characteristics of the watershed as well. Key parameters used to evaluate the limnological condition of a lake include temperature, dissolved oxygen, total phosphorus, chlorophyll-*a*, and Secchi transparency.

Temperature

Temperature is important in determining the type of organisms that may live in a lake. For example, trout prefer temperatures below 68°F. Temperature also determines how water mixes in a lake. As the ice cover breaks up on a lake in the spring, the water temperature becomes uniform from the surface to the bottom. This period is referred to as "spring turnover" because water mixes throughout the entire water column. As the surface waters warm, they are underlain by a colder, more dense strata of water. This process is called thermal stratification. Once thermal stratification occurs, there is little mixing of the warm surface waters with the cooler bottom waters. The transition layer that separates these layers is referred to as the "thermocline." The thermocline is characterized as the zone where temperature drops rapidly with depth. As fall approaches, the warm surface waters begin to cool and become more dense. Eventually, the surface temperature drops to a point that allows the lake to undergo complete mixing. This period is referred to as "fall turnover." As the season progresses and ice begins to form on the lake, the lake may stratify again. However, during winter stratification, the surface waters (at or near 32°F) are underlain by slightly warmer water (about 39°F). This is sometimes referred to as "inverse stratification" and occurs because water is most dense at a temperature of about 39°F. As the lake ice melts in the spring, these stratification cycles are repeated (Figure 8). Shallow lakes do not stratify. Lakes that are 15 to 30 feet deep may stratify and destratify with storm events several times during the year.

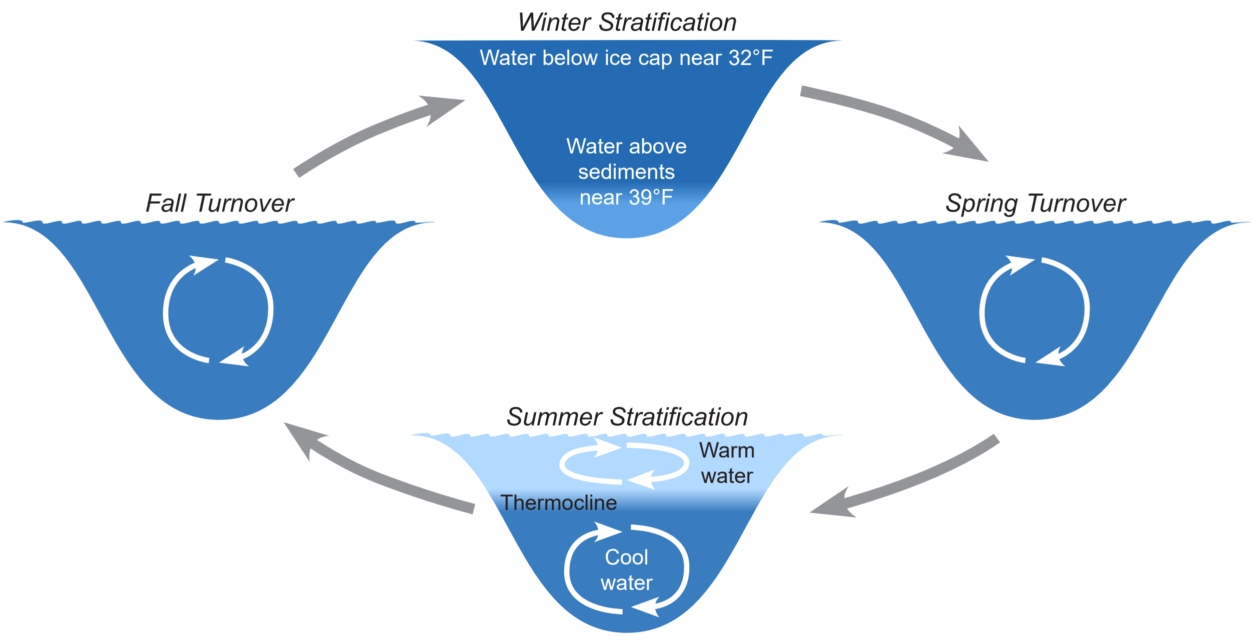


Figure 8. Seasonal thermal stratification cycles.

Dissolved Oxygen

An important factor influencing lake water quality is the quantity of dissolved oxygen in the water column. The major inputs of dissolved oxygen to lakes are the atmosphere and photosynthetic activity by aquatic plants. An oxygen level of about 5 mg/L (milligrams per liter, or parts per million) is required to support warm water fish. In lakes deep enough to exhibit thermal stratification, oxygen levels are often reduced or depleted below the thermocline once the lake has stratified. This is because deep water is cut off from plant photosynthesis and the atmosphere, and oxygen is consumed by bacteria that use oxygen as they decompose organic matter (plant and animal remains) at the bottom of the lake. Bottom-water oxygen depletion is a common occurrence in eutrophic and some mesotrophic lakes. Thus, eutrophic and most mesotrophic lakes cannot support cold water fish because the cool, deep water (that the fish require to live) does not contain sufficient oxygen.

Phosphorus

The quantity of phosphorus present in the water column is especially important since phosphorus is the nutrient that most often controls aquatic plant growth and the rate at which a lake ages and becomes more eutrophic. In the presence of oxygen, lake sediments act as a phosphorus trap, retaining phosphorus and, thus, making it unavailable for aquatic plant growth. However, if bottom-water oxygen is depleted, phosphorus will be released from the sediments and may be available to promote aquatic plant growth. In some lakes, the internal release of phosphorus from the bottom sediments is the primary source of phosphorus loading (or input).

By reducing the amount of phosphorus in a lake, it may be possible to control the amount of aquatic plant growth. In general, lakes with a phosphorus concentration greater than 20 µg/L (micrograms per liter, or parts per billion) are able to support abundant plant growth and are classified as nutrient-enriched or eutrophic.

Chlorophyll-*a*

Chlorophyll-*a* is a pigment that imparts the green color to plants and algae. A rough estimate of the quantity of algae present in lake water can be made by measuring the amount of chlorophyll-*a* in the water column. A chlorophyll-*a* concentration greater than 6 µg/L is considered characteristic of a eutrophic condition.

Secchi Transparency

A Secchi disk is often used to estimate water clarity. The measurement is made by fastening a round, black and white, 8-inch disk to a calibrated line (Figure 9). The disk is lowered over the deepest point of the lake until it is no longer visible, and the depth is noted. The disk is then raised until it reappears. The average between these two depths is the Secchi transparency. Generally, it has been found that aquatic plants can grow at a depth of approximately twice the Secchi transparency measurement. In eutrophic lakes, water clarity is often reduced by algae growth in the water column, and Secchi disk readings of 7.5 feet or less are common.

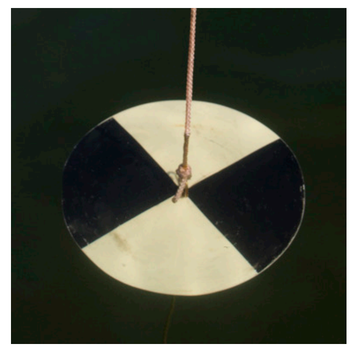


Figure 9. Secchi disk.

Lake Classification Criteria

Ordinarily, as phosphorus inputs (both internal and external) to a lake increase, the amount of algae will also increase. Thus, the lake will exhibit increased chlorophyll-*a* levels and decreased transparency. A summary of lake classification criteria developed by the Michigan Department of Natural Resources is shown in Table 2.

TABLE 2

LAKE CLASSIFICATION CRITERIA

Lake Classification	Total Phosphorus (µg/L)[1]	Chlorophyll-*a* (µg/L)[1]	Secchi Transparency (feet)
Oligotrophic	Less than 10	Less than 2.2	Greater than 15.0
Mesotrophic	10 to 20	2.2 to 6.0	7.5 to 15.0
Eutrophic	Greater than 20	Greater than 6.0	Less than 7.5

In addition to the parameters commonly used to evaluate lake trophic state, there are several other measurements that can be made to characterize water quality. A brief description of some of these parameters follows:

pH and Total Alkalinity

pH is a measure of the amount of acid or base in the water. The pH scale ranges from 0 (acidic) to 14 (alkaline or basic) with neutrality at 7. The pH of most lakes in the Upper Midwest ranges from 6.5 to 9.0 (MDEQ 2012; Table 3). In addition, according to MDEQ (2019):

> While there are natural variations in pH, many pH variations are due to human influences. Fossil fuel combustion products, especially automobile and coal-fired power plant emissions, contain nitrogen oxides and sulfur dioxide, which are converted to nitric acid and sulfuric acid in the atmosphere. When these acids combine with moisture in the atmosphere, they fall to earth as acid rain or acid snow. In some parts of the United States, especially the Northeast, acid rain has resulted in lakes and streams becoming acidic, resulting in conditions which are harmful to aquatic life. The problems associated with acid rain are lessened if limestone is present, since it is alkaline and neutralizes the acidity of the water.
>
> Most aquatic plants and animals are adapted to a specific pH range, and natural populations may be harmed by water that is too acidic or alkaline. Immature stages of aquatic insects and young fish are extremely sensitive to pH values below 5. Even microorganisms which live in the bottom sediment and decompose organic debris cannot live in conditions which are too acidic. In very acidic waters, metals which are normally bound to organic matter and sediment are released into the water. Many of these metals can be toxic to fish and humans. Below a pH of about 4.5, all fish die.

The Michigan Water Quality Standard (Part 4 of Act 451) states that pH shall be maintained within the range of 6.5 to 9.0 in all waters of the state.

Alkalinity, also known as acid-neutralizing capacity or ANC, is the measure of the pH-buffering capacity of water in that it is the quantitative capacity of water to neutralize an acid. pH and alkalinity are closely linked and are greatly impacted by the geology and soil types that underlie a lake and its watershed. According to MDEQ (2012):

> Michigan’s dominant limestone geology in the Lower Peninsula and the eastern Upper Peninsula contributes to the vast majority of Michigan lakes being carbonate-bicarbonate dominant [which increases alkalinity and moderates pH] and lakes in the western Upper Peninsula having lower alkalinity and thus lesser buffering capacity.

The alkalinity of most lakes in the Upper Midwest is within the range of 23 to 148 milligrams per liter, or parts per million, as calcium carbonate (MDEQ 2012; Table 3).

TABLE 3
pH AND ALKALINITY OF UPPER MIDWEST LAKES

Measurement	Low	Moderate	High
pH (in standard units)	Less than 6.5	6.5 to 9.0	Greater than 9.0
Total Alkalinity or ANC (in mg/L as $CaCO_3$[1])	Less than 23	23 to 148	Greater than 148

1 mg/L $CaCO_3$ = milligrams per liter as calcium carbonate.

Total Suspended Solids

According to MDEQ (2019):

> Total suspended solids (TSS) include all particles suspended in water which will not pass through a filter... Most people consider water with a TSS concentration less than 20 mg/L to be clear. Water with TSS levels between 40 and 80 mg/L tends to appear cloudy, while water with concentrations over 150 mg/L usually appears dirty.

Chloride

Normally, chloride is a very minor component of freshwater systems and background concentrations are generally less than about 10 milligrams per liter (Wetzel 2001; Fuller and Taricska 2012, Figure 10). However, chloride pollution from sources such as road salting, industrial or municipal wastewater, water softeners, and septic systems can increase chloride levels in lakes. Increased chloride levels can reduce biological diversity and, because chloride increases the density of water, elevated chloride levels can prevent a lake from completely mixing during spring and fall. Michigan's water quality standards require that waters designated as a public water supply source not exceed 125 milligrams per liter of chlorides as a monthly average.

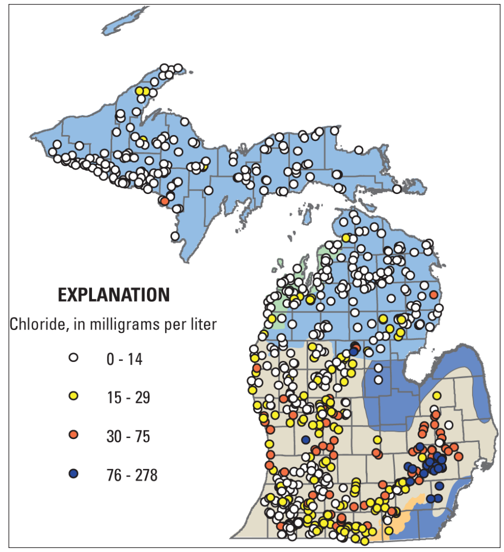


Figure 10. Lake chloride levels (2001–10) in USEPA ecoregions. Fuller and Taricska 2012.

Fecal Coliform Bacteria

A primary consideration in evaluating the suitability of a lake to support swimming and other water-based recreational activities is the level of bacteria in the water. *Escherichia coli* (*E. coli*) is a bacteria commonly associated with fecal contamination. The current State of Michigan public health standard for total body contact recreation (e.g., swimming) for a single sampling event requires that the number of *E. coli* bacteria not exceed 300 per 100 milliliters of water.

WHITE LAKE WATER QUALITY

During the course of study, samples were collected on May 16 and August 9, 2018 at five-foot depth intervals over the two deep basins of White Lake to evaluate baseline water quality conditions. In addition, samples were collected on July 25, 2018 from near-shore areas of the lake to measure fecal coliform (*E. coli*) bacteria levels (Figure 11 and Tables 4 through 7).

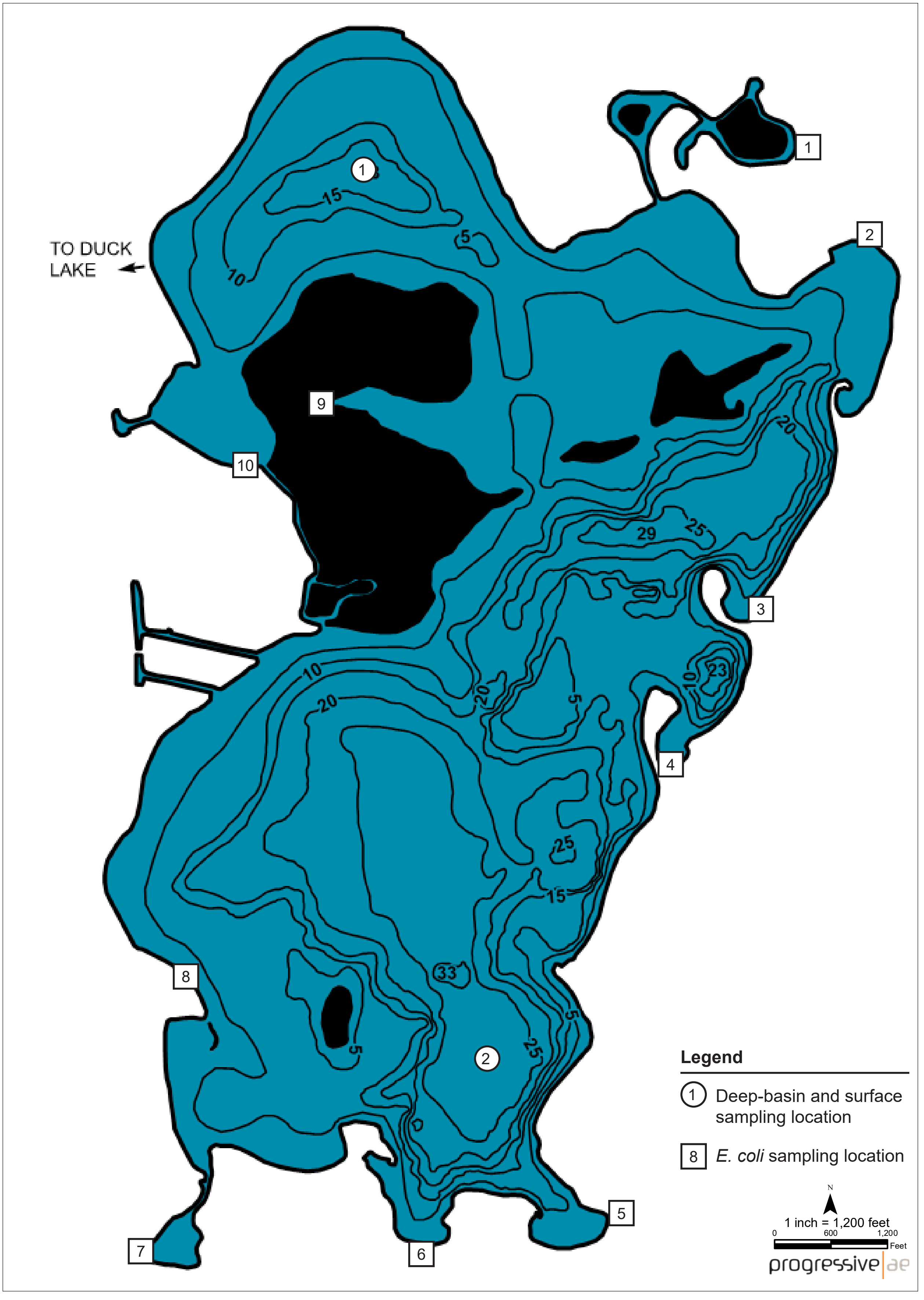


Figure 11. White Lake sampling location map.

TABLE 4
WHITE LAKE DEEP BASIN WATER QUALITY DATA

Date	Station	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	Total Phosphorus (µg/L)[2]	Total Suspended Solids (mg/L)[1]	Chloride (mg/L)[1]	pH (S.U.)[3]	Total Alkalinity (mg/L as $CaCO_3$)[4]
16-May-18	1	1	66	---	<5	4	101	8.7	132
16-May-18	1	5	65	10.8	<5	4	102	8.7	128
16-May-18	1	10	62	10.6	<5	4	102	8.7	127
16-May-18	1	15	60	10.2	<5	4	104	8.7	130
16-May-18	2	1	64	9.1	<5	4	100	8.6	127
16-May-18	2	5	64	10.2	<5	4	99	8.6	128
16-May-18	2	10	63	9.6	<5	4	99	8.6	125
16-May-18	2	15	60	9.7	<5	4	100	8.5	129
16-May-18	2	20	60	9.6	<5	4	99	8.5	127
16-May-18	2	25	58	9.9	<5	4	100	8.5	128
16-May-18	2	30	56	9.8	<5	4	101	8.5	123
09-Aug-18	1	1	80	9.2	<5	6	100	8.6	130
09-Aug-18	1	5	80	8.3	14	6	100	8.7	140
09-Aug-18	1	10	80	7.4	9	6	101	8.6	138
09-Aug-18	1	15	76	1.7	98	11	106	8.1	167
09-Aug-18	2	1	79	9.2	5	7	99	8.8	125
09-Aug-18	2	5	79	8.5	12	7	99	8.8	136
09-Aug-18	2	10	79	8.5	12	17	99	8.8	132
09-Aug-18	2	15	79	7.9	16	10	100	8.6	136
09-Aug-18	2	20	76	3.0	27	7	96	8.1	137
09-Aug-18	2	25	70	2.4	34	12	97	7.8	145

1 mg/L = milligrams per liter = parts per million.
2 µg/L = micrograms per liter = parts per billion.
3 S.U. = standard units
4 mg/L CaCO3 = milligrams per liter as calcium carbonate.

TABLE 5
WHITE LAKE PHOSPHORUS AND NITROGEN DATA

Date	Station	Sample Depth (feet)	Total Phosphorus (µg/L)[1]	Nitrate Nitrogen (mg/L)[2]	Nitrite Nitrogen (mg/L)[2]	Total Kjeldahl Nitrogen (mg/L)[2]	Nitrogen to Phosphorus Ratio
16-May-18	1	1	<5	<0.1	<0.1	1.6	352
16-May-18	1	5	<5	<0.1	<0.1		
16-May-18	1	10	<5	<0.1	<0.1	1.1	264
16-May-18	1	15	<5	<0.1	<0.1	1.1	260
16-May-18	2	1	<5	0.1	<0.1	1.0	241
16-May-18	2	5	<5	0.1	<0.1	1.1	260
16-May-18	2	10	<5	0.1	<0.1	0.3	108
16-May-18	2	15	<5	0.1	<0.1	0.3	100
16-May-18	2	20	<5	0.1	<0.1	<0.1	65
16-May-18	2	25	<5	0.1	<0.1	<0.1	66
16-May-18	2	30	<5	0.1	<0.1	<0.1	64

TABLE 6
WHITE LAKE SURFACE WATER QUALITY DATA

Date	Sample Location	Secchi Transparency (feet)	Chlorophyll-*a* (µg/L)[1]
16-May-18	1	11	1
16-May-18	2	27	1
09-Aug-18	1	9	1
09-Aug-18	2	14	3

During the May sampling, White Lake was cool and well-oxygenated from the surface to the bottom (Table 4). Thermal stratification was observed at both deep basins with relatively warm waters near the surface underlain by cooler waters near the lake bottom. During the August sampling period, low dissolved oxygen levels were measured at the bottom of both deep basin sites. These data indicate that White Lake can sustain cool- and warm-water fish such as bass, pike and walleye, however, the lake lacks a refuge for cold-water fish such as trout.

Phosphorus levels in White Lake were generally low except in August when phosphorus levels were considerably higher at the bottom of each deep basin (Table 4). The elevated phosphorus levels were likely the result of phosphorus release from the deep-water lake sediments as oxygen was depleted from the bottom water during late summer. Although deep-water phosphorus levels are high, the volume of water containing high-phosphorus is small. Thus, it does not appear that internal phosphorus loading is significant in White Lake.

1 µg/L = micrograms per liter = parts per billion.
2 mg/L = milligrams per liter = parts per million.

Nitrogen and phosphorus are the primary nutrients that sustain aquatic plant growth. In most Michigan lakes, phosphorus is the nutrient that limits plant growth in that it is the nutrient in least supply relative to the nutritional needs of aquatic plants (Fuller and Taricska 2012). In lakes, if the ratio of total nitrogen to total phosphorus is greater than 15:1, the lake is considered phosphorus-limited. The ratio of total nitrogen to total phosphorus in White Lake greatly exceeded 15:1, indicating White Lake is phosphorus-limited (Table 5).

Chlorophyll-*a* concentrations measured during both the May and August sampling periods were low while Secchi transparency measurements were good to excellent (Table 6). These data indicate that algae growth in the open waters of White Lake at the time of sampling was minimal. Total suspended solids in the water column were low in both May and August and contributed to the good water clarity in White Lake.

Compared to other regions of the state, chloride levels are generally higher in the urbanized watersheds of southeast Michigan (Fuller and Taricska 2012). The elevated chloride levels measured in White Lake (Table 4) are likely the result of road salting. Although elevated, chloride levels in White Lake are not at a level considered deleterious to aquatic life (U.S. Environmental Protection Agency 1988).

Alkalinity in White Lake is moderate, and the lake is well-buffered against pollution inputs that could impact pH (Table 4). The pH in White Lake is within a range that can readily support aquatic life.

With the exception of two sampling locations in the canals, bacteria levels measured during the July sampling period were below Michigan’s water quality standard for total body contact recreational activities (Table 7). There were no obvious indications of malfunctioning septic systems at the time of sampling. The elevated bacteria levels in the canals may be related to the lack of water circulation in these areas that can create conditions which allow bacteria to flourish. In the future, sampling of near-shore areas should be conducted on a periodic basis to determine if elevated bacteria levels persist in the lake.

TABLE 7
WHITE LAKE BACTERIOLOGICAL DATA

Site Number	*E. coli* Bacteria/100 mL[1]
1	291
2	1
3	<1
4	8
5	5
6	20
7	313
8	20
9	8
10	980

Based upon the water quality data collected during the study, White Lake is mesotrophic. The lake has low phosphorus and chlorophyll-*a* levels, and good to excellent transparency. With the exception of elevated chlorophyll-*a* levels measured during the original engineering study of White Lake (Cleary Engineering, Inc. 1986), the mesotrophic classification is generally consistent with historical data. Historical data for White Lake are compiled and summarized in Appendix B.

1 mL = milliliter

AQUATIC PLANTS

In evaluating aquatic plant growth and plant control alternatives, it is important to remember that aquatic plants are an important ecological component of lakes. They produce oxygen from photosynthesis, provide food and habitat for fish, and help stabilize shoreline and bottom sediments (Figure 12).

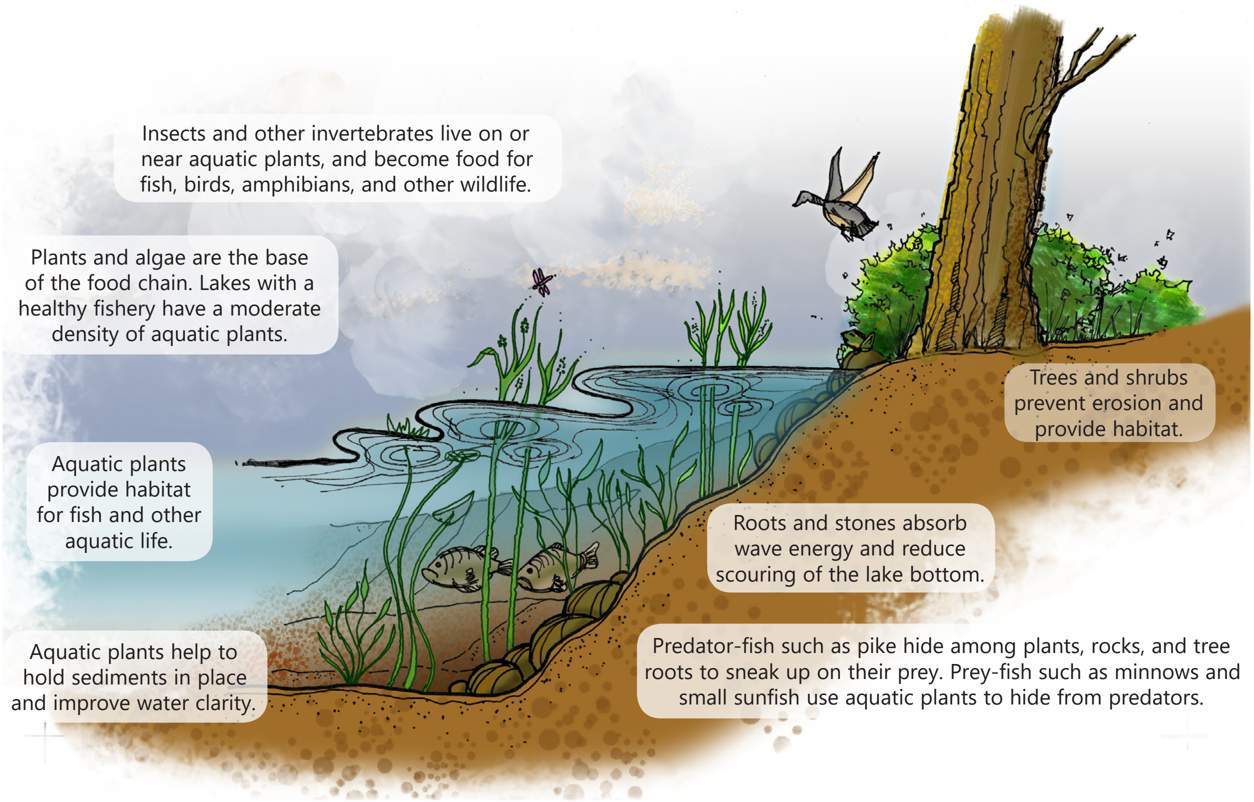


Figure 12. Benefits of aquatic plants.

The distribution and abundance of aquatic plants are dependent on several variables, including light penetration, bottom type, temperature, water levels, and the availability of plant nutrients. The term "aquatic plants" includes both the algae and the larger aquatic plants or macrophytes. The macrophytes can be categorized into four groups: the emergent, the floating-leaved, the submersed, and the free floating (Figure 13). Each plant group provides unique habitat essential for a healthy fishery.

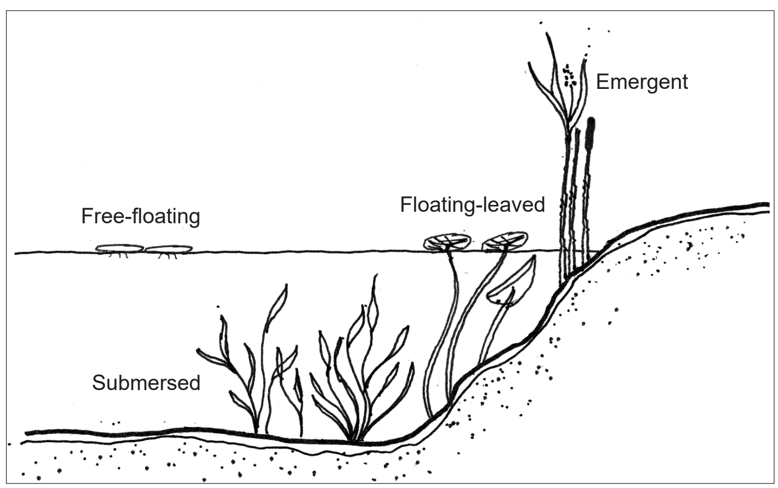


Figure 13. Aquatic plant groups.

However, while most aquatic plants are beneficial, exotic (i.e., non-native) plant species are a problem in many lakes. Exotic aquatic plants often have aggressive and invasive growth tendencies and, in some lakes, they quickly out-compete native plants and gain dominance. In Michigan lakes, exotic plants of primary concern include Eurasian milfoil (*Myriophyllum spicatum*, Figure 14) and starry stonewort (*Nitellopsis obtusa*, Figure 15). Both of these plants have been documented in White Lake (Pullman 2009).

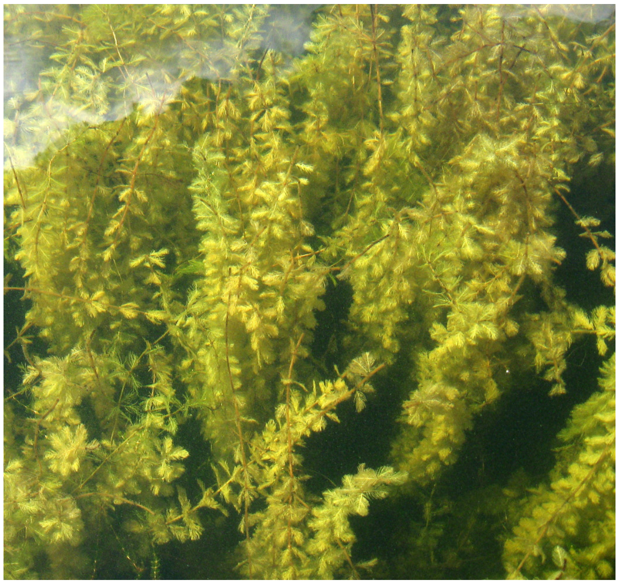


Figure 14. Eurasian milfoil (*Myriophyllum spicatum*).

Figure 15. Starry stonewort (*Nitellopsis obtusa*).

Eurasian milfoil generally becomes established early in the growing season and can grow at greater depths than most plants. Eurasian milfoil often forms a thick canopy at the lake surface that can degrade fish habitat and seriously hinder recreational activity. Once introduced into a lake system, Eurasian milfoil may out-compete and displace more desirable plants and become the dominant species.

Starry stonewort looks like a rooted plant, but it is actually an alga. It was first found in the Detroit River in the 1980's and has since infested hundreds of inland lakes (Brown 2015, Schloesser et al. 1986). Starry stonewort closely resembles the native aquatic plant Chara. However, unlike Chara, which is generally considered to be a beneficial plant, starry stonewort tends to colonize deeper water and can form dense mats several feet thick. Starry stonewort can impede navigation, and quickly displace native plants. Fisheries biologists have expressed concern that starry stonewort may cover valuable fish habitat and spawning areas.

White Lake Aquatic Plants

A hydro-acoustic survey of White Lake was conducted on July 25, 2018 to measure plant bio-volume (i.e., the height of plants in the water column; Appendix A). A plant bio-volume map of White Lake is shown in Figure 16. When plants grow to the surface they occupy 100% of the water column, and those areas are shown in red on the map. When plants are not present, 0% of the water column contains plants, and those areas are shown in blue. When plants grow half-way to the surface, they occupy 50% of the water column, and are shown in yellow. The plant bio-volume map shows that the location of White Lake plant beds in 2018 were generally consistent with those shown on the original 1953 map, with submersed vegetation present throughout much of the north basin and the west shore of the south basin.

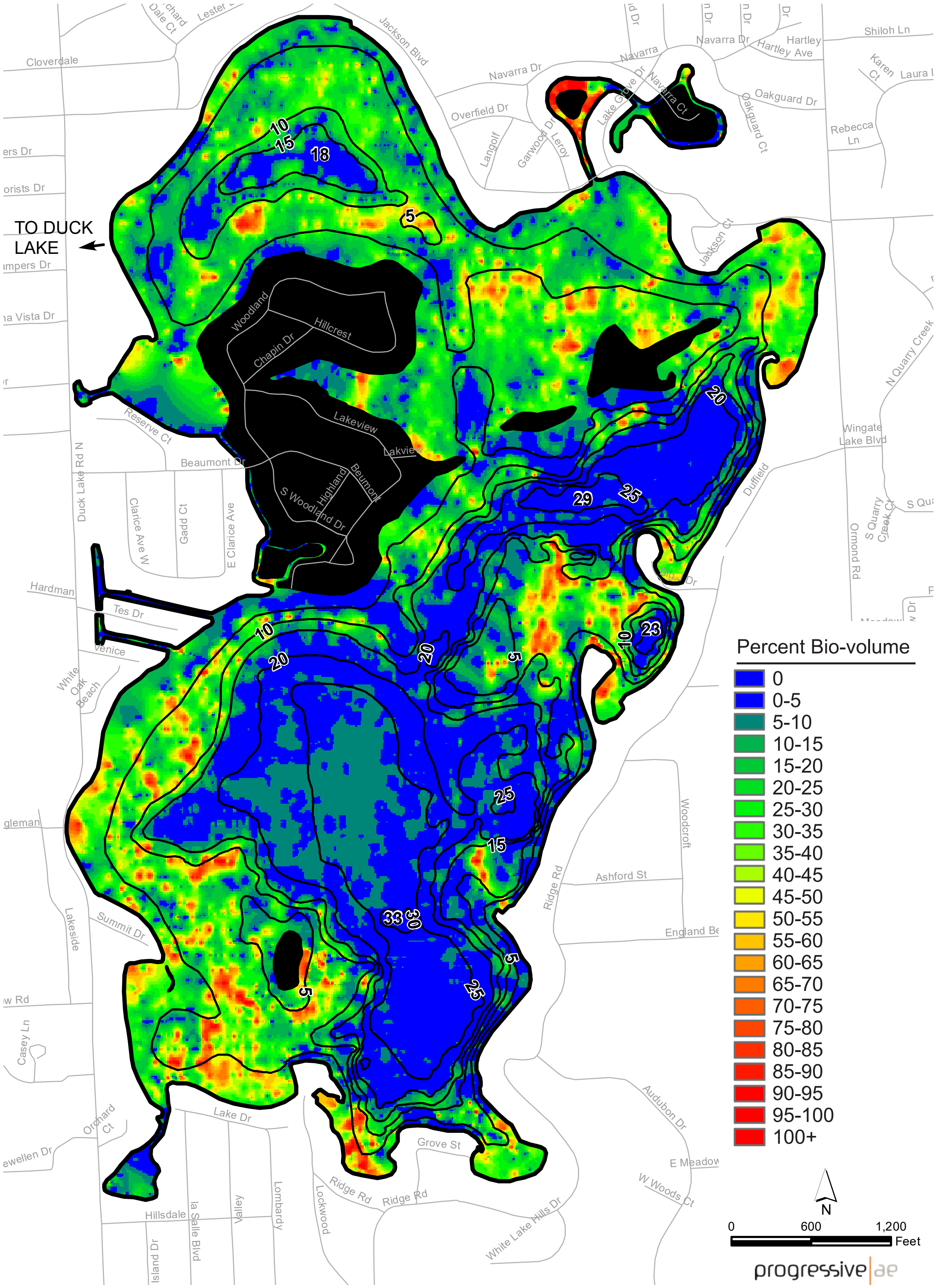


Figure 16. White Lake aquatic plant bio-volume map.

On August 9, 2018, an aquatic vegetation survey was conducted to determine the type and distribution of aquatic plants in White Lake (Table 8, Appendix A). At the time of the survey, thirteen submersed plant species, one free-floating, two floating-leaved, and six emergent plant species were observed in the lake. With the exception of the exotic plant species found during the survey, the native plants in White Lake provide important ecological benefits.

TABLE 8
WHITE LAKE AQUATIC PLANTS
August 9, 2018

Common Name	Scientific Name	Group	Percent of Sites Where Plant Was Found
Chara	*Chara* sp.	Submersed	68
Richardson's pondweed	*Potamogeton richardsonii*	Submersed	46
Wild celery	*Vallisneria americana*	Submersed	42
Eurasian milfoil	*Myriophyllum spicatum*	Submersed	36
Starry stonewort	*Nitellopsis obtusa*	Submersed	34
Slender naiad	*Najas flexilis*	Submersed	30
Bladderwort	*Utricularia vulgaris*	Submersed	15
Coontail	*Ceratophyllum demersum*	Submersed	11
Thin-leaf pondweed	*Potamogeton* sp.	Submersed	10
Variable pondweed	*Potamogeton gramineus*	Submersed	6
Illinois pondweed	*Potamogeton illinoensis*	Submersed	5
Large-leaf pondweed	*Potamogeton amplifolius*	Submersed	3
Milfoil	*Myriophyllum heterophyllum*	Submersed	1
Duckweed	*Lemna minor*	Free-floating	1
White waterlily	*Nymphaea odorata*	Floating-leaved	63
Yellow waterlily	*Nuphar* sp.	Floating-leaved	11
Purple loosestrife	*Lythrum salicaria*	Emergent	11
Buttonbush	*Cephalanthus occidentalis*	Emergent	10
Swamp loosestrife	*Decodon verticillatus*	Emergent	7
Cattail	*Typha* sp.	Emergent	5
Iris	*Iris* sp.	Emergent	4
Bulrush	*Schoenoplectus* sp.	Emergent	3

Aquatic Plant Control

The main goal of aquatic plant control in White Lake should be to control the spread of exotic and invasive plants, while maintaining a diversity of beneficial native plant species. Currently, the exotic and invasive plants Eurasian milfoil and starry stonewort are both present in White Lake. Alternatives for aquatic plant control include mechanical harvesting, diver-assisted suction harvesting, and the application of aquatic herbicides. Because Eurasian milfoil can spread by vegetative propagation, it is generally ill-advised to attempt control via mechanical harvesting. Diver-assisted suction harvesting can be effective on small infestations of a few acres or less, but on a larger scale this option is cost-prohibitive. A native aquatic insect called the milfoil weevil (*Euhrychiopsis lecontei*) has also been used in an effort to control Eurasian milfoil. However, these attempts have been largely unsuccessful, and milfoil weevils are no longer commercially available. A recent study found that a combination of mechanical harvesting and herbicide treatments may provide the best control of starry stonewort (Glisson et al. 2018). However, like Eurasian milfoil, starry stonewort can spread by vegetative propagation and harvesting may cause dispersal and accelerated spread of the plant (Larkin et al. 2018).

The most common method of aquatic plant control is the application of aquatic herbicides. This is the method currently used on White Lake (Appendix C). There are two types of herbicides: systemic and contact. Systemic herbicides are taken up by the plant and translocated to the roots, resulting in more complete control. Contact herbicides only impact the portions of the plant that come into contact with the herbicide. They also tend to be broad-spectrum and can kill desirable, non-target plants. Contact herbicides work relatively quickly while systemic herbicides generally take several weeks to kill the targeted plant. However, control with contact herbicides is often short-lived and some plants can re-grow within a few weeks. For Eurasian milfoil control, systemic herbicides are generally recommended in that they can kill milfoil with little or no impact to desirable native plants. For starry stonewort, contact herbicides are generally more effective.

Copper sulfate and various chelated copper-based products are commonly used to control algae growth. Unlike most aquatic herbicides, copper is persistent in the aquatic environment. Copper deposits rapidly in the soil and does not remain in the water column (Johnson 2015). Although classified as practically non-toxic to moderately toxic, the Environmental Protection Agency (EPA) recommends only partial treatment of a water body and 10-14 days between treatments to reduce risk to aquatic life. Additionally, the EPA has imposed maximum annual rates for treatment (Johnson 2015).

In Michigan, aquatic herbicide use is regulated under Part 33, Aquatic Nuisance Control, of the Natural Resources and Environmental Protection Act, PA 451 of 1994. Prior to herbicide treatments, a permit must be acquired from the Michigan Department of Environmental Quality (MDEQ). MDEQ regulates which herbicides can be applied, dose rates, and areas of the lake where treatments are allowed. If herbicides are applied according to label instructions and permit requirements, they should pose no danger to public health or the environment. In general, herbicides should only be applied to the extent needed to control nuisance plant species. In fact, excessive treatment of aquatic plants, especially with contact herbicides, can cause a number of problems including algal blooms, dissolved oxygen depletion, and loss of valuable fish habitat.

Hybrid Milfoil

Eurasian milfoil is not the only type of milfoil found in Michigan. There are several native milfoil species, such as northern milfoil (*Myriophyllum sibiricum*). Some native species closely resemble Eurasian milfoil and are commonly mistaken for it. However, the native milfoils rarely form dense, impenetrable plant beds like Eurasian milfoil often does. In some lakes, including White Lake, hybridization between exotic Eurasian milfoil (*M. spicatum*) and native northern milfoil (*M. sibiricum*) is occurring. Genetic testing has found milfoil hybrids to be widely dispersed across the northern portion of the United States, and hybrid milfoil appears to be widespread in Michigan (Sturtevant et al. 2009, Moody and Les 2007). The presence of hybrid milfoil is important because hybridity in plants is often linked to invasive traits. In fact, hybrid milfoil may be more invasive than Eurasian milfoil (LaRue et al. 2012). There is concern in the scientific community that hybrids could have a competitive advantage over, and ultimately displace both northern milfoil and Eurasian milfoil (LaRue et al. 2012). Recent research indicates that hybrid milfoils may exhibit increased tolerance to some herbicides (LaRue et al. 2012, Thum et al. 2012).

As part of the study, milfoil samples were collected from White Lake and sent to researchers at the Montana State University who are working on a Michigan Invasive Species grant to evaluate hybrid milfoil resistance and sensitivity to various herbicides. Analysis of the milfoil samples collected from White Lake indicate that two milfoil hybrid variants occur in the lake. Specific recommendations on what herbicide dose rates may be most effective in controlling the spread of these plants are forthcoming.

WHITE LAKE FISHERY

Fish surveys conducted by the Michigan Department of Natural Resources (MDNR) in 2007 and 2013 (Appendix D) indicate the White Lake supports both a warm-water (panfish and bass) and a cool-water (pike and walleye) fishery. While fish populations appear healthy, the MDNR noted that the most abundant panfish in the lake, bluegill and pumpkinseed sunfish, were growing slightly below state averages, while largemouth bass were growing slightly above the state average. Northern pike were abundant in the lake and, although pike were growing at a rate below the state average, the density of the pike population in White Lake was considered excellent. Walleye have been stocked regularly in the lake since 1980. Post-stocking data indicate that there is good survival of stocked walleye, although conditions in White Lake are not conducive to natural reproduction of walleye.

The MDNR cited several possible reasons for the reduced growth rate of some fishes in the lake including heavy shoreline development and loss of near-shore habitat, removal of large woody material, and annual herbicide treatments. Other factors cited that could be impacting the fishery included fishing and boating pressure.

Conclusions and recommendations in the 2013 MDNR report included:

- The population of largemouth bass in White Lake is doing very well with a high percentage of fish meeting the legal-size limit.
- The walleye population, though somewhat low, is adequate to sustain a walleye fishery in White Lake, and walleye stocking should be continued.
- The excellent northern pike population indicates that there is consistently successful spawning and recruitment of this species despite the high level of shoreline development.

ZEBRA MUSSELS

Zebra mussels (*Dreissana polymorpha*) are a non-native mollusk from Eastern Europe and Asia (Figure 17). Their introduction into the Great Lakes region in the 1980's appears to be the result of the discharge of ballast water from transatlantic ships. Zebra mussels have been found in all of the Great Lakes; they have been reported in 70 of Michigan's 83 counties and in about 250 inland lakes statewide (Central Michigan University Undated, White 2014). Zebra mussels are currently present in White Lake.

Figure 17. Zebra mussels. Photo source: Dr. David Jude, University of Michigan

Zebra mussels are filter feeders that feed primarily on phytoplankton (algae) in the water column. In some lakes infested with zebra mussels, water transparency has increased as zebra mussels have removed algae and other particulate matter from the water column. Increased transparency has resulted in increased growth of rooted plants in some lakes. Zebra mussels also appear to consume desirable types of algae such as diatoms but reject undesirable cyanobacteria (blue-green algae). This has raised concerns that lakes infested with zebra mussels may experience a shift in algal communities from desirable algal types to nuisance cyanobacteria. Another concern is that filter feeding by zebra mussels may remove microscopic algae, called phytoplankton, which, in turn, support microscopic animals, called zooplankton, a primary food source for larval and juvenile fish. Deleterious impacts to native clams and crayfish populations have been observed due to dense growths of attached zebra mussels. While some of the impacts associated with zebra mussels may appear desirable, such as increased transparency, overall ecosystem impacts of zebra mussels can be problematic.

In the right conditions, zebra mussels are highly prolific and can spread rapidly. Adult zebra mussels will generally colonize hard substrates such as docks, shore stations, boats and pipes. In many lakes, the zebra mussel populations decline substantially following the initial infestation, with remnant populations persisting at much lower densities. This phenomenon may be temperature-related. Research conducted on Gull Lake in Barry County, Michigan found that elevated summer water temperatures in the shallow waters appear to have contributed to a substantial decline in the zebra mussel population in that lake, and researchers reported anecdotal evidence of similar zebra mussel declines in other areas of the state (White 2014). These findings suggest that summer water temperatures in many Michigan lakes may be too warm for zebra mussel populations to thrive.

Once in a lake, there is no available technology that will eradicate zebra mussels on a lake-wide basis. A natural soil bacterium (*Pseudomonas flourescens*), marketed under the trade name Zequanox®, has recently been approved by the U.S. Environmental Protection Agency for zebra mussel control. However, while this product appears effective at control on a small-scale basis, it is not 100% effective and is cost-prohibitive on a large-scale basis (Central Michigan University Undated).

WHITE LAKE WATERSHED

The White Lake watershed is about 5.5 square miles in area, which is 6 times larger than the lake itself. In the early days, development around White Lake was sparse (Figure 18). However, over the years, substantial development occurred in the region. Today, approximately 550 homes border the lake and much of the White Lake watershed is urbanized (Figure 19). With urbanization, many of the forested and wetland areas in the watershed have been replaced by roof tops, roads, driveways and other impervious surfaces. As such, rainwater no longer infiltrates into the ground and has the potential to runoff into the lake, carrying with it fertilizers, oil, gas and other pollutants. Successful, long-term management of White Lake will require that lake residents take steps to minimize watershed-related impacts to the lake.

Figure 18. White Lake area, 1909. Source: USGS

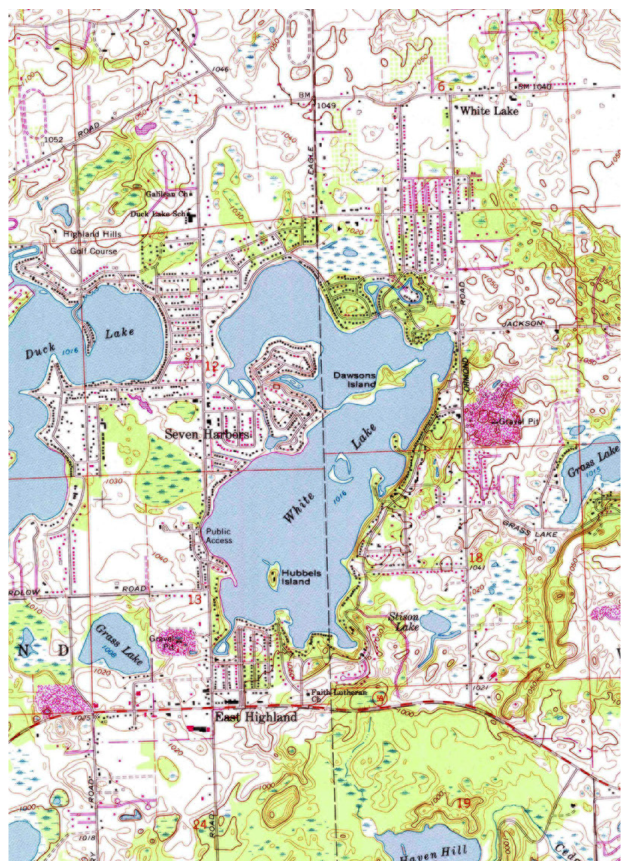


Figure 19. White Lake area, 1983. Source: USGS

In the first-ever National Lakes Assessment conducted by the U.S. Environmental Protection Agency, researchers found that lakes lacking natural shoreland habitat were three times more likely to be in poor biological condition (USEPA 2010). Currently, less than about 15% percent of White Lake's shoreline contains natural vegetation. The Michigan Department of Natural Resources found that almost two-thirds of the White Lake shoreline was artificially armored in some fashion (MDNR 2013). In order to protect the quality of White Lake, it will be important to preserve and restore natural shoreland areas. Information for lake residents on shoreland management is included in Appendix E.

Septic systems also have the potential to be a major source of pollution input to White Lake (Cleary Engineering, Inc. 1986). Septic input can be expected to increase over time as the limited ability of soils to bind septic pollutants is exceeded. Until such time as public sewer service is available for the White Lake area, lake residents should be vigilant in the management of their on-site septic systems.

Conclusions and Recommendations

White Lake is relatively large and shallow with a long, convoluted shoreline. Mapping of the lake conducted during the course of study indicates that there has been little fill-in of the main body of the lake since it was first mapped 65 years ago. The watershed that drains to the lake is six times larger than the lake and, today, much of the watershed is urbanized. Overall, water quality conditions in White Lake are good. The lake has relatively low nutrient levels, good transparency, and algae growth in the open waters of the lake is minimal. A comparison of historical and recent data indicates water quality has been relatively stable over the years. White Lake naturally supports abundant aquatic plant growth. The lake supports a good diversity of beneficial, native plant species, and ongoing plant control activities are focused on preventing the spread of exotic and invasive plants species in the lake. To help ensure water quality conditions in White Lake are sustained over the long term, steps should be taken in conjunction with in-lake improvements to educate lake residents regarding watershed management practices.

Based on the results of the study, management recommendations for White Lake are summarized as follows:

- Aquatic Plant Control: The primary objective of the aquatic plant control program should be to control the spread of exotic and invasive plants, while maintaining a diversity of beneficial native plant species. Herbicides should only be applied to the extent needed to control targeted nuisance plant species. For Eurasian milfoil control, systemic herbicides are generally recommended in that they can kill milfoil with little or no impact to desirable native plants. For starry stonewort, contact herbicides are generally more effective.
- Water Quality Monitoring: Much of the historical data available for White Lake was derived from the Citizens Lake Monitoring Program (CLMP). This data provided valuable insight into water quality conditions in the lake. It is recommended that the White Lake Citizens League continue participation in CLMP.
- Watershed Management: The dissemination of information regarding watershed management practices is essential to the long-term protection of White Lake. Information on the importance of watershed management should continue to be provided to lake residents through the White Lake Citizens League website and other means. An important step lake residents could take to protect White Lake over the long term would be to support construction of a community sewer system.

Appendix A
Study Methods

PHYSICAL

The White Lake shoreline was digitized from aerial orthodigital photography (SEMCOG Orthos 2015) using ArcGIS software. A GPS-guided hydro-acoustic survey of White Lake was conducted on July 25, 2018, in which transects were established at 100-foot intervals across the lake and the lake bottom was scanned along each transect using high-definition SONAR (Lowrance HDS 9). Hydro-acoustic data was uploaded to CMAP BioBase for a kriging analysis to create interpolated mapping. Lake volume was calculated using the conical frustrum method (Wetzel and Likens 2010). Lake volume was divided by surface area to calculate mean depth. Shoreline development factor was calculated from shoreline length and surface area (Wetzel and Likens 2010). Shallowness ratio was calculated from the area less than five feet in depth divided by the total lake area (Wagner 1991). The estimate of the hydraulic residence time of White Lake was derived from discharge data provided by the Michigan Department of Environmental Quality Hydrologic Studies Unit.

CHEMICAL

Water quality sampling was conducted in May and August of 2018 at the two deep basins within White Lake. Temperature was measured using a YSI Model 550A probe. Samples were collected at 10-foot intervals with a Van Dorn bottle to be analyzed for dissolved oxygen, total phosphorus, chloride, total suspended solids, pH, and total alkalinity. Dissolved oxygen samples were fixed in the field and then transported to Progressive AE for analysis using the modified Winkler method (Standard Methods procedure 4500-O C). pH was measured in the field using a YSI EcoSense pH meter. Remaining samples were placed on ice and transported to Prein and Newhof[1] and to Progressive AE for analysis. Total phosphorus, chloride, and total suspended solids were analyzed at Prein and Newhof using Standard Methods procedure 4500-P-E, EPA procedure 300.0, and Standard Methods procedure 2540D, respectively. Total alkalinity was titrated at Progressive AE using Standard Methods procedure 2320 B. In addition to the depth-interval samples at each deep basin, Secchi transparency was measured and composite chlorophyll-*a* samples were collected from the surface to a depth equal to twice the Secchi transparency. Chlorophyll-*a* samples were analyzed by Prein and Newhof using Standard Methods procedure 10200 H.

BIOLOGICAL

The plant survey of White Lake was conducted in general conformance with Michigan Department of Environmental Quality (MDEQ) Procedures for Aquatic Vegetation Surveys (2016). GPS reference points were established at 300-foot intervals along the shoreline (Figure A1). At each reference point, an assessment was made of the type and relative abundance of all plant species present. Plant densities were recorded in accordance with MDEQ procedures as follows: (a) = found: one or two plants of a species found at a site, equivalent to less than 2% of the total site surface area; (b) = sparse: scattered distribution of a species at a site, equivalent to between 2% and 20% of the total site surface area; (c) = common: common distribution of a species where the species is easily found at a site, equivalent to between 21% and 60% of the total site surface area; (d) = dense: dense distribution of a species where the species is present in considerable quantities throughout a site, equivalent to greater than 60% of the total site surface area. Data for each individual assessment site was then recorded, compiled and tabulated to evaluate the relative abundance of all plant species in White Lake.

Escherichia coli bacteria samples were collected along the shoreline of White Lake and placed on ice for delivery to the Kent County Health Department[2] for analysis.

1 3260 Evergreen Drive NE, Grand Rapids, MI 49525
2 700 Fuller NE, Grand Rapids, MI 49503

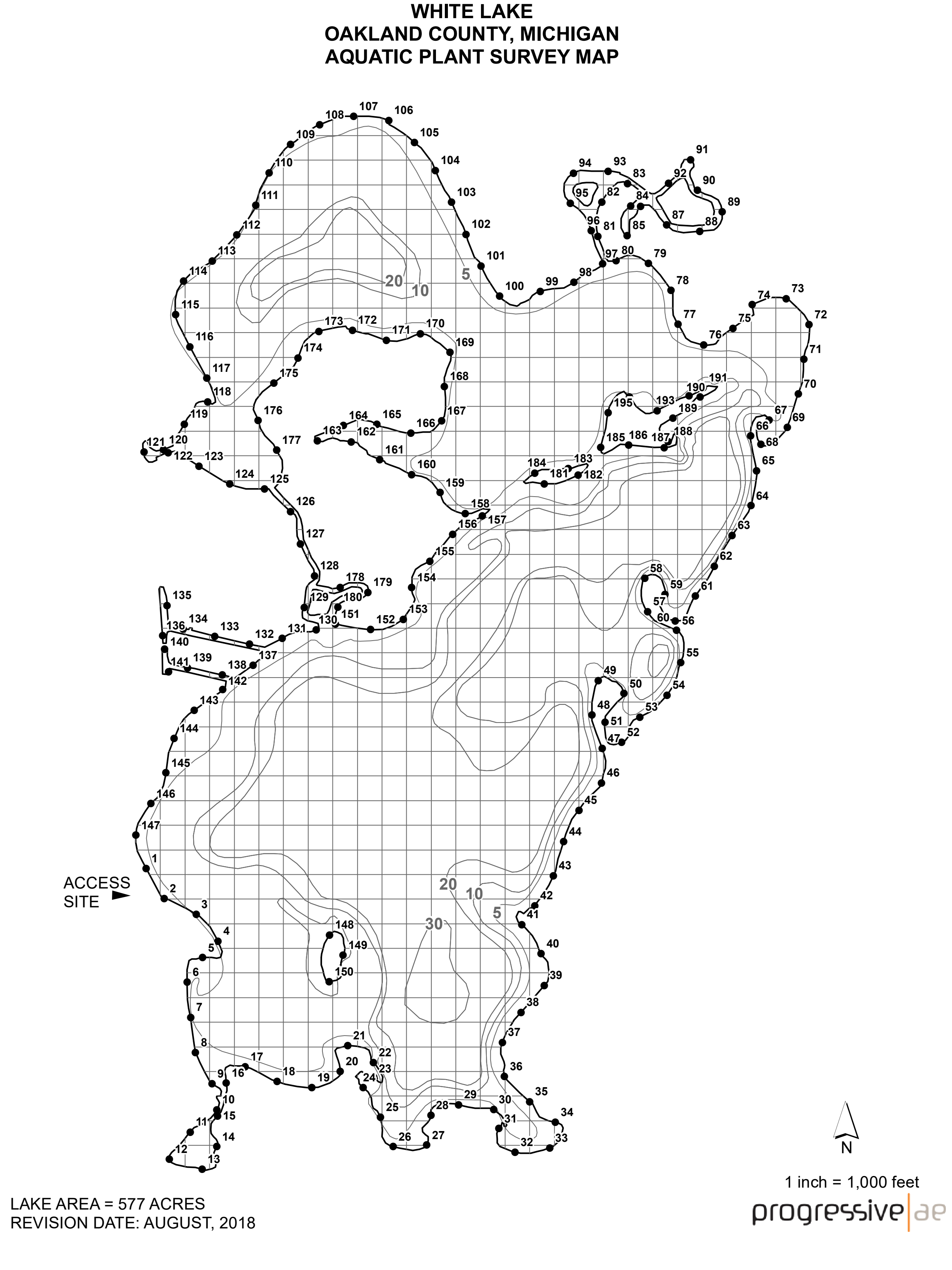


Figure A1. White Lake aquatic plant survey map.

Appendix B
Historical Water Quality Data

TABLE B1
USGS SITE 423938083335601 (SOUTH BASIN WHITE LAKE) WATER QUALITY DATA

Date	Sample Depth (feet)	Temperature (°F)	Dissolved Oxygen (mg/L)[1]	pH (S.U.)[2]
9-Apr-07	3	41	12.9	8.6
9-Apr-07	6	41	12.6	8.6
9-Apr-07	9	41	12.4	8.6
9-Apr-07	12	41	12.3	8.6
9-Apr-07	15	40	12.3	8.6
9-Apr-07	18	40	12.3	8.5
9-Apr-07	21	40	12.3	8.5
9-Apr-07	24	40	12.3	8.5
9-Apr-07	27	40	12.3	8.5
9-Apr-07	29	40	10.1	8.2
8-Aug-07	2	81	9.0	9.4
8-Aug-07	4	81	9.2	9.4
8-Aug-07	6	79	9.2	9.4
8-Aug-07	8	79	9.2	9.4
8-Aug-07	10	79	9.4	9.4
8-Aug-07	12	79	9.4	9.4
8-Aug-07	14	79	9.3	9.4
8-Aug-07	16	79	9.3	9.4
8-Aug-07	18	77	9.2	9.2
8-Aug-07	20	75	4.7	8.5
8-Aug-07	22	73	1.1	7.8
8-Aug-07	24	72	0.5	7.6
8-Aug-07	26	70	0.3	7.6
8-Aug-07	28	66	0.3	7.6

1 mg/L = milligrams per liter = parts per million.
2 S.U. = standard units

TABLE B2
USGS SOUTH BASIN WHITE LAKE PHOSPHORUS AND NITROGEN DATA

Date	Sample Depth (feet)	Total Phosph. (µg/L)[1]	Ammonia and Ammonium (mg/L)[2]	Nitrate and Nitrite (mg/L)[2]	Total Kjeldahl Nitrogen (mg/L)[2]	Organic Nitrogen (mg/L)[2]
9-Apr-07	3	14	0.008	0.031	0.42	0.41
9-Apr-07	27	13	0.007	0.03	0.41	0.4
8-Aug-07	3	8	0.006		0.45	0.44
8-Aug-07	28	39	0.009	0.002	0.63	0.62

TABLE B3
USGS NORTH BASIN WHITE LAKE PHOSPHORUS AND NITROGEN DATA

Date	Sample Depth (feet)	Total Phosph. (µg/L)[1]	Ammonia and Ammonium (mg/L)[2]	Nitrate and Nitrite (mg/L)[2]	Total Kjeldahl Nitrogen (mg/L)[2]	Organic Nitrogen (mg/L)[2]
9-Apr-07	3	11	0.012	0.034	0.45	0.44
9-Apr-07	15	11	0.013	0.035	0.44	0.43
8-Aug-07	3	10	0.004	0.003	0.44	0.44
8-Aug-07	15	10	0.005	0.004	0.43	0.42

TABLE B4
USGS WHITE LAKE SURFACE WATER QUALITY DATA

Date	Sample Location	Secchi Transparency (feet)	Chlorophyll-*a* (µg/L)[1]
9-Apr-07	South Basin	20	1.3
8-Aug-07	South Basin	22	3.1
9-Apr-07	North Basin	12	1.1
8-Aug-07	North Basin		4

1 µg/L = micrograms per liter = parts per billion.
2 mg/L = milligrams per liter = parts per million.

WATER QUALITY DATA FOR WHITE LAKE

DATE	STATION	DEPTH	TEMP	D.O.	CHL A	SECCHI	NITR	ALK	pH	COND	PHO
8/12/86	1	0	24	8.5	12	11	<10	121	8.2	360	17
8/12/86	1	5	23	8.5	6	---	<10	121	8.1	340	30
8/12/86	1	10	22	8.5	6	---	<10	119	8.1	340	17
8/12/86	1	15	22	8.5	6	---	<10	119	8.1	340	23
8/12/86	1	20	22	7.0	12	---	<10	121	8.1	340	17
8/12/86	1	25	20	1.4	20	---	<10	120	8.1	340	16
8/12/86	1	28	19	1.4	18	---	---	---	---	---	---
8/12/86	2	0	24	8.6	52	11	<10	119	8.2	340	8
8/12/86	3	0	24	8.8	13	11	<10	121	8.2	340	8
8/12/86	4	0	23	8.5	34	11	<10	121	8.2	340	8
8/12/86	5	0	23	8.8	10	10	<10	121	8.2	340	13
8/12/86	6	0	25	8.4	16	11	<10	121	8.2	340	17
8/12/86	7	0	24	8.1	32	8	<10	123	8.2	340	16
8/12/86	8	0	24	8.2	44	8	<10	121	8.2	340	16
8/12/86	9	0	22	8.5	36	8	<10	132	8.2	350	16
8/12/86	10	0	24	8.7	10	8	<10	132	8.2	350	17

TEMP — Temperature in °C
D.O. — Dissolved oxygen in milligrams per liter
CHL A — Chlorophyll a in micrograms per liter (corrected)
SECCHI — Secchi disk transparency in feet
NITR — Total nitrate in micrograms per liter
ALK — Alkalinity in milligrams per liter as $CaCO_3$
pH — Hydrogen ion concentration in standard units
COND — Conductivity in umhos/cm at 25°C
PHOS — Total phosphorus in micrograms per liter

Cooperative Lakes Monitoring Program

Michigan Lakes– Ours to Protect

2017 Data Report for

White Lake, Oakland County

Site ID: 630684

42.66056°N, 83.56556°W

The CLMP is brought to you by:

Michigan Clean Water Corps

DEQ

Michigan State University

Huron River Watershed Council

Great Lakes Commission des Grands Lacs

Michigan Lake and Stream Associations

About this report:
This report is a summary of the data that have been collected through the Cooperative Lakes Monitoring Program. The contents have been customized for your lake. The first page is a summary of the Trophic Status Indicators of your lake (Secchi Disk Transparency, Chlorophyll-a, Spring Total Phosphorus, and Summer Total Phosphorus). Where data are available, they have been summarized for the most recent field season, five years prior to the most recent field season, and since the first year your lake has been enrolled in the program.

If you did not take 8 or more Secchi disk measurements or 4 or more chlorophyll measurements, there will not be summary data calculated for these parameters. These numbers of measurements are required to ensure that the results are indicative of overall summer conditions.

If you enrolled in Dissolved Oxygen/Temperature, the summary page will have a graph of one of the profiles taken during the late summer (typically August or September). If your lake stratifies, we will use a graph showing the earliest time of stratification, because identifying the timing of this condition and the depth at which it occurs is typically the most important use of dissolved oxygen measurements.

The back of the summary page will be an explanation of the Trophic Status Index and where your lake fits on that scale.

The rest of the report will be aquatic plant summaries, Score the Shore results, and larger graphs, including all Dissolved Oxygen/Temperature Profiles that you recorded. For Secchi Disk, Chlorophyll, and Phosphorus parameters, you need to have two years of data for a graph to make logical sense. Therefore if this is the first year you have enrolled in the CLMP, you will not receive a graph for these parameters.

Remember that some lakes see a lot of fluctuation in these parameters from year to year. Until you have eight years worth of data, consider all trends to be preliminary.

To learn more about the CLMP monitoring parameters or get definitions to unknown terms, check out the CLMP Manual, found at: **https://micorps.net/wp-content/uploads/CLMP-Manual.pdf**

Thank you!
The CLMP leadership team would like to thank you for all of your efforts over the past year. The CLMP would not exist without dedicated and hardworking volunteers!

The CLMP Leadership Team is made of: Marcy Knoll Wilmes, Jean Roth, Jo Latimore, Paul Steen, Scott Brown, Laura Kaminski, and Michele Leduc-Lapierre

Questions?
If you have questions on this report or believe that the tabulated data for your lake in this report are in error please contact:
Paul Steen (psteen@hrwc.org), MiCorps Program Manager

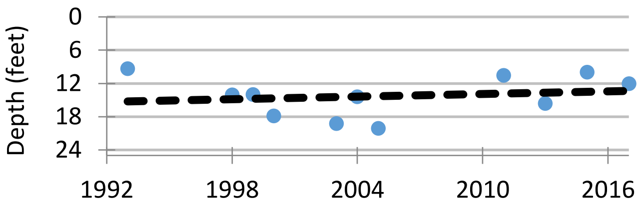
Site ID: 630684

White Lake, Oakland County
2017 CLMP Results

Cooperative Lakes Monitoring Program

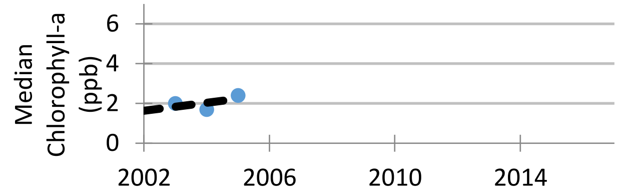
Secchi Disk Transparency (feet)

Year	# Readings	Min	Max	Average	Std. Dev	Carlson TSI
2017	9	9.0	15.0	12.0	2.2	41
2012-2016	35	9.0	20.0	12.0	1.6	41
1993-2011	116	3.5	26.0	14.9	3.0	39
2017 All CLMP Lakes	2949	1.0	52.0	12.3	2.7	43



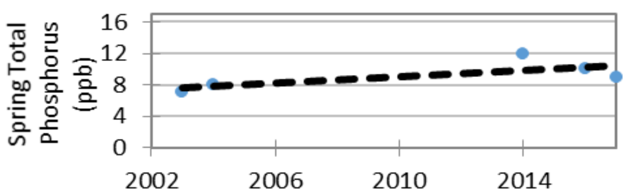
Chlorophyll-a (parts per billion)

Year	# Samples	Min	Max	Median	Std. Dev	Carlson TSI
2005	5	1.7	4.2	2.4	1.0	39
2000-2004	13	1.0	12.0	1.9	0.8	37
2017 All CLMP Lakes	628	< 1.0	28.0	1.8	4.3	36



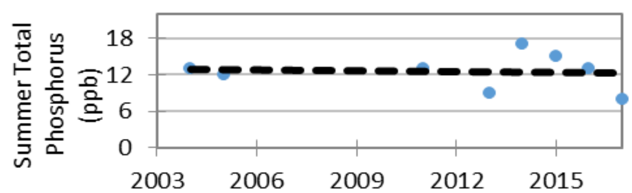
Spring Phosphorus (parts per billion)

Year	# Samples	Min	Max	Average	Std. Dev
2017	1	9.0	9.0	9.0	NA
2012-2016	2	10.0	12.0	11.0	1.4
2003-2011	2	7.0	8.0	7.5	0.7
2017 All CLMP Lakes	188	<= 3	120	11.6	12.7



Summer Phosphorus (parts per billion)

Year	# Samples	Min	Max	Average	Std. Dev	Carlson TSI
2017	1	8.0	8.0	8.0	NA	34
2012-2016	4	9.0	17.0	13.5	3.4	41
2004-2011	3	12.0	13.0	12.7	0.6	41
2017 All CLMP Lakes	208	<= 3	52.0	11.1	8.4	39



Dissolved Oxygen and Temperature Profile

This lake does not have recent (within 5 years) dissolved oxygen/water temperature data available. Consider enrolling in this parameter next year. Fish, insects, mollusks, and crustaceans need dissolved oxygen to live in water. By late summer, many lakes stratify, with cold anoxic water on the bottom and warm, oxygen rich water on the surface. Anoxic (oxygen-depleted) water occurring too close to the surface is a sign of nutrient enrichment. Understanding the pattern of dissolved oxygen and water temperature in a lake is important for assessing nutrient problems as well as the health of the biological community.

Summary

Average TSI	2017	2012-2016	1993-2011
White Lake	38	40	37
All CLMP Lakes	40	40	42

With an average TSI score of 38 based on 2017 Secchi transparency and summer total phosphorus data, this lake is rated between the oligotrophic and mesotrophic lake classification.

Long term trends indicate that the trophic status parameters have not changed beyond minor year-to year variation since monitoring began.

** = No sample received W= Value is less than the detection limit (<3 ppb) T= Value reported is less than the reporting limit (5 ppb). Result is estimated.*
<1.0 = Chlorophyll-a: Sample value is less than limit of quantification (<1 ppb).

Trophic Status Index Explained

In 1977, limnologist Dr. Robert Carlson developed a numerical scale (0-100) where the numbers indicate the level of nutrient enrichment. Using the proper equations, we can convert results from Summer Total Phosphorus, Secchi Depth, and Chlorophyll-a to this Trophic Status Index (TSI). The TSI numbers are furthermore grouped into general categories (oligotrophic, mesotrophic, eutrophic, and hypereutrophic), to quickly give us a way to understand the general nutrient level of any lake.

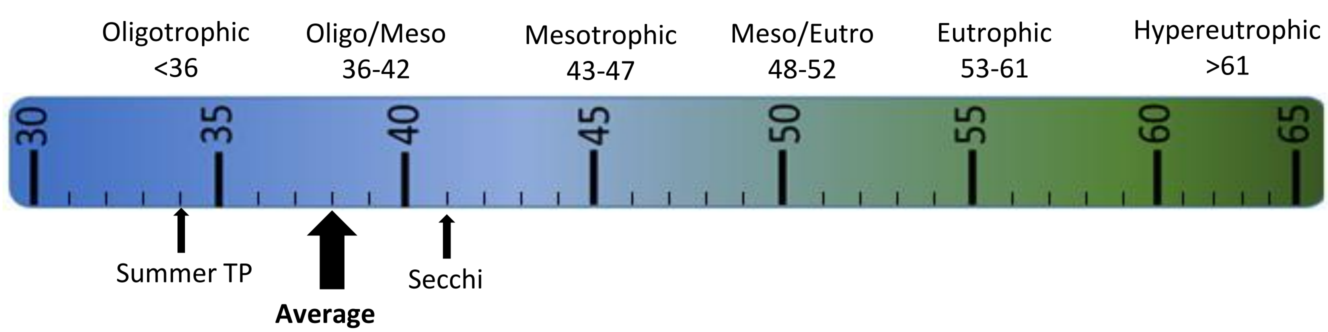
The tables below give the results-to-TSI conversions for the water quality data ranges normally seen in the CLMP. The formulas for this conversion can be found in the CLMP manual (https://micorps.net/wp-content/uploads/CLMP-Manual.pdf).

Phosphorus (ppb)	TSI Value
<5	<27
6	30
8	34
10	37
12	40
15	43
18	46
21	48
24	50
32	54
36	56
42	58
48	60
>50	>61

Secchi Depth (ft)	TSI Value
>30	<28
25	31
20	34
15	38
12	42
10	44
7.5	48
6	52
4	57
<3	>61

Chlorophyll-a (ppb)	TSI Value
<1	<31
2	37
3	41
4	44
6	48
8	51
12	55
16	58
22	61
>22	>61

TSI for White Lake in 2017	
Average	38
Secchi Disk	41
Summer TP	34
Chlorophyll-a	



Oligotrophic: Generally deep and clear lakes with little aquatic plant or algae growth. These lakes maintain sufficient dissolved oxygen in the cool, deep-bottom waters during late summer to support cold water fish, such as trout and whitefish.

Mesotrophic: Lakes that fall between oligotrophic and eutrophic. Mid-ranged amounts of nutrients.

Eutrophic: Highly productive eutrophic lakes are generally shallow, turbid, and support abundant aquatic plant growth. In deep eutrophic lakes, the cool bottom waters usually contain little or no dissolved oxygen. Therefore, these lakes can only support warm water fish, such as bass and pike.

Hypereutrophic: A specialized category of euthrophic lakes. These lakes exhibit extremely high productivity, such as nuisance algae and weed growth.

Site ID: 630684

White Lake, Oakland County
2017 CLMP Aquatic Plant Results

White Lake does not have aquatic plant data available for 2017. Consider enrolling in an aquatic plant parameter next year.

Why is monitoring aquatic plants important?

A major component of the plant community in lakes is the large, leafy, rooted plants. Compared to the microscopic algae the rooted plants are large. Sometimes they are collectively called the “macrophytes” (“macro” meaning large and “phyte” meaning plant). These macrophytes are the plants that people sometimes complain about and refer to as lake weeds.

Far from being weeds, macrophytes or rooted aquatic plants are a natural and essential part of the lake, just as grasses, shrubs and trees are a natural part of the land. Their roots are a fabric for holding sediments in place, reducing erosion and maintaining bottom stability. They provide habitat for fish, including structure for food organisms, nursery areas, foraging and predator avoidance. Waterfowl, shore birds and aquatic mammals use plants to forage on and within, and as nesting materials and cover.

Though plants are important to the lake, overabundant plants can negatively affect fish populations, fishing and other recreational activities. Rooted plant populations increase in abundance as nutrient concentrations increase in the lake. As lakes become more eutrophic rooted plant populations increase. They are rarely a problem in oligotrophic lakes, only occasionally a problem in mesotrophic lakes, sometimes a problem in eutrophic lakes, and often a problem in hypereutrophic lakes.

However, sometimes a lake is invaded by an aquatic plant species that is not native to Michigan. In these cases, even nutrient poor oligotrophic lakes can be threatened. Some of these exotic plants, like Curly-leaf Pondweed, Eurasian Milfoil, Starry Stonewort, and Hydrilla can be extremely disruptive to the lake’s ecosystem and recreational activities.

To avoid a takeover by exotic plants, it is necessary to use Integrated Pest Management (IPM) strategies: monitoring, early detection, rapid response, maintenance control, and preventive management. For more information on these strategies, check out Integrated Pest Management for Nuisance Exotics in Michigan Inland Lakes (MSU Extension Water Quality Publication WQ-56, available at https://micorps.net/lake-monitoring/clmp-documents/)

The CLMP offers two parameters on aquatic plants. In the Exotic Aquatic Plant Watch, volunteers concentrate on monitoring and early detection of exotic invasive plants only. In Aquatic Plant Identification and Mapping, volunteers identify all native and non-native plants. In both parameters, volunteers create lake maps or use digital tools to georeference where the plants are found.

Site ID: 630684

White Lake, Oakland County
2017 Score the Shore Results

White Lake does not have shoreline habitat assessment results for 2017. Consider enrolling in this parameter next year!

Why is the Score the Shore parameter important?

Healthy shorelines are an important and valuable component of the lake ecosystem. The shoreline area is a transition zone between water and land, and should be a very diverse environment that provides habitat for a great variety of fish, plants, birds, and other animals. A healthy shoreline area is also essential for maintaining water quality, slowing runoff, and limiting erosion.

However, Michigan's inland lake shorelines are threatened. Extensive development, often combined with poor shoreline management practices, can reduce or eliminate natural shoreline habitat and replace it with lawn and artificial erosion control such as sea walls and rock. As a result, shoreline vegetation is dramatically altered, habitat is lost, and water quality declines.

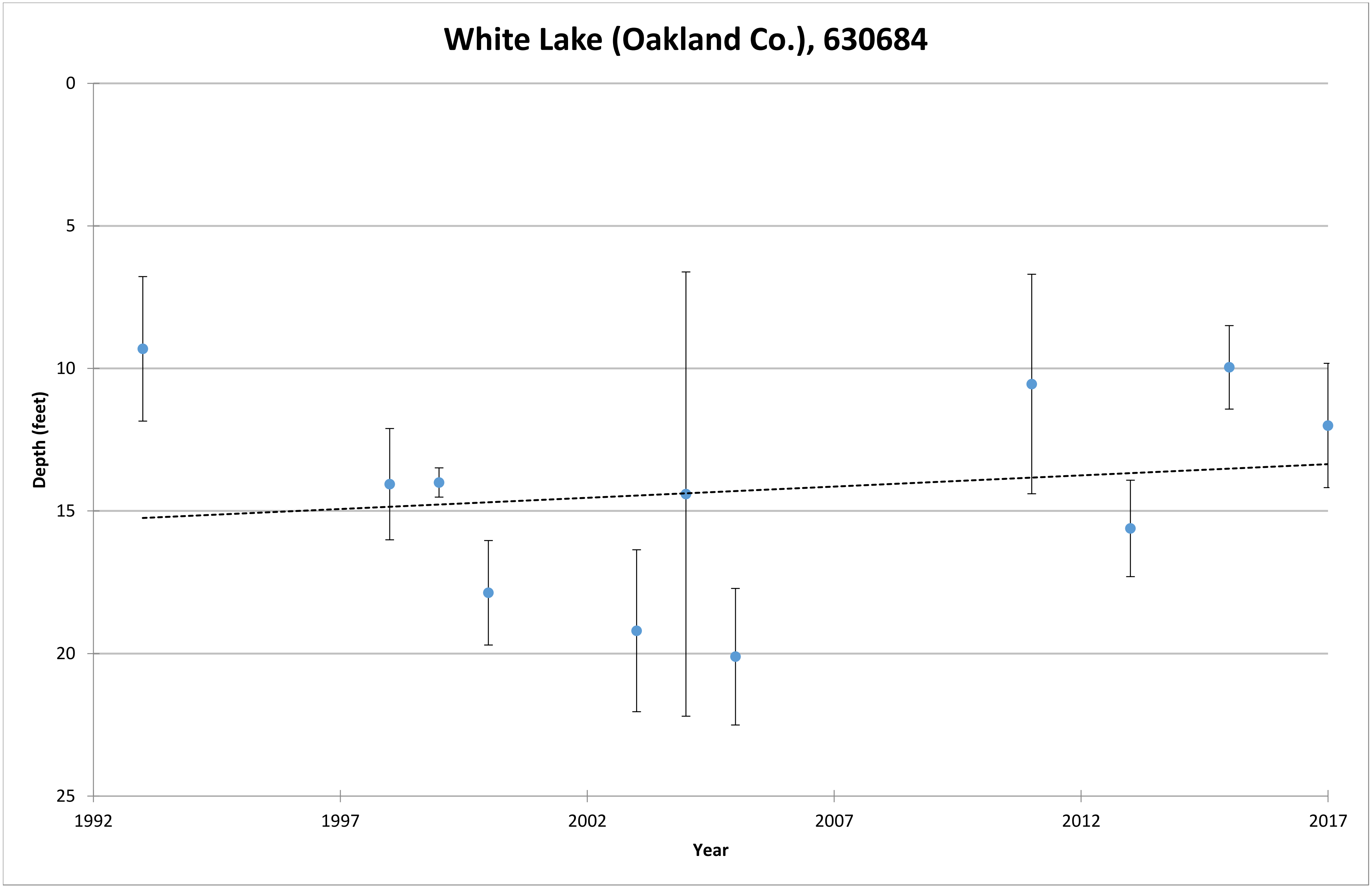
Therefore, in 2017 the MiCorps Cooperative Lakes Monitoring Program introduced a new monitoring program – Score the Shore – that enables volunteers to assess the quality of their lake's shoreline habitat.

The information gathered during this assessment will allow lake communities to identify high-quality areas that can be protected, as well as opportunities for improvement. Score the Shore data, combined with educational resources describing the value of healthy shorelines and how to restore and maintain them, can be incorporated into lake management planning and used for educating lakefront property owners. The Michigan Natural Shoreline Partnership (MNSP) is a collaboration of agencies and professionals that promotes natural shoreline practices to protect Michigan's inland lakes. The MNSP website (www.mishorelinepartnership.org) includes materials and information that can be used in educational efforts. MNSP also offers training for professional educators and landscape contractors, and maintains a list of trained educators who may be available to speak to your community about natural shorelines.

Score the Shore data, just like all CLMP data, will also be available to any interested parties through the MiCorps Data Exchange (www.micorps.net). State agency staff and researchers regularly access CLMP data to better understand and manage Michigan's inland lakes.

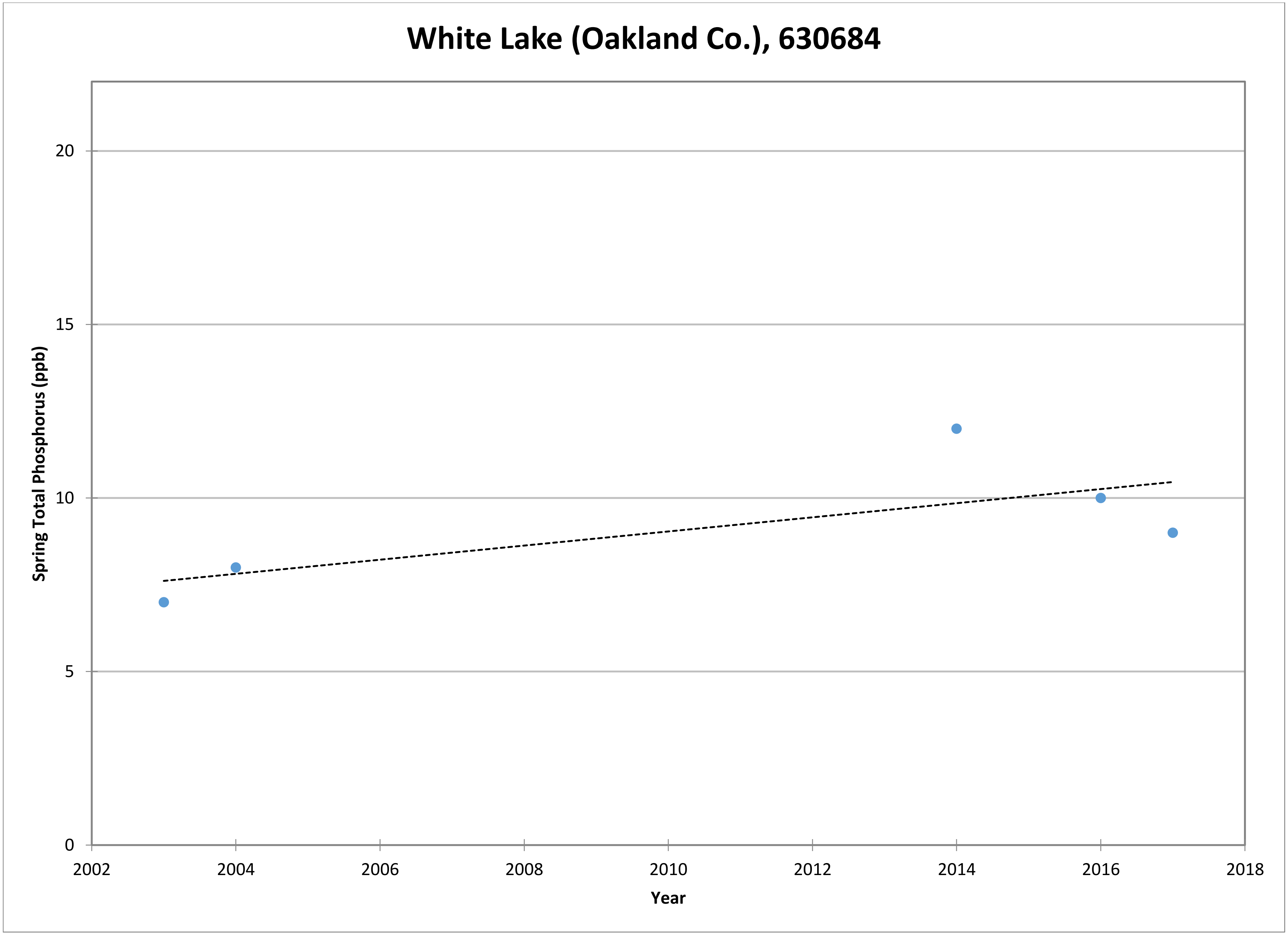
Score the Shore is a descriptive process for assessing shoreline quality on Michigan's inland lakes. It is also a valuable educational tool. Score the Shore is not a regulatory program, nor is it intended to tell people what they can and cannot do on their property. The Michigan Department of Environmental Quality's Inland Lakes and Streams Program has responsibility for shoreline protection on public lakes. To learn about their shoreline protection program, including construction permitting and recommendations for shoreline management, visit www.mi.gov/deqinlandlakes.

COOPERATIVE LAKES MONITORING PROGRAM
SUMMER MEAN TRANSPARENCY

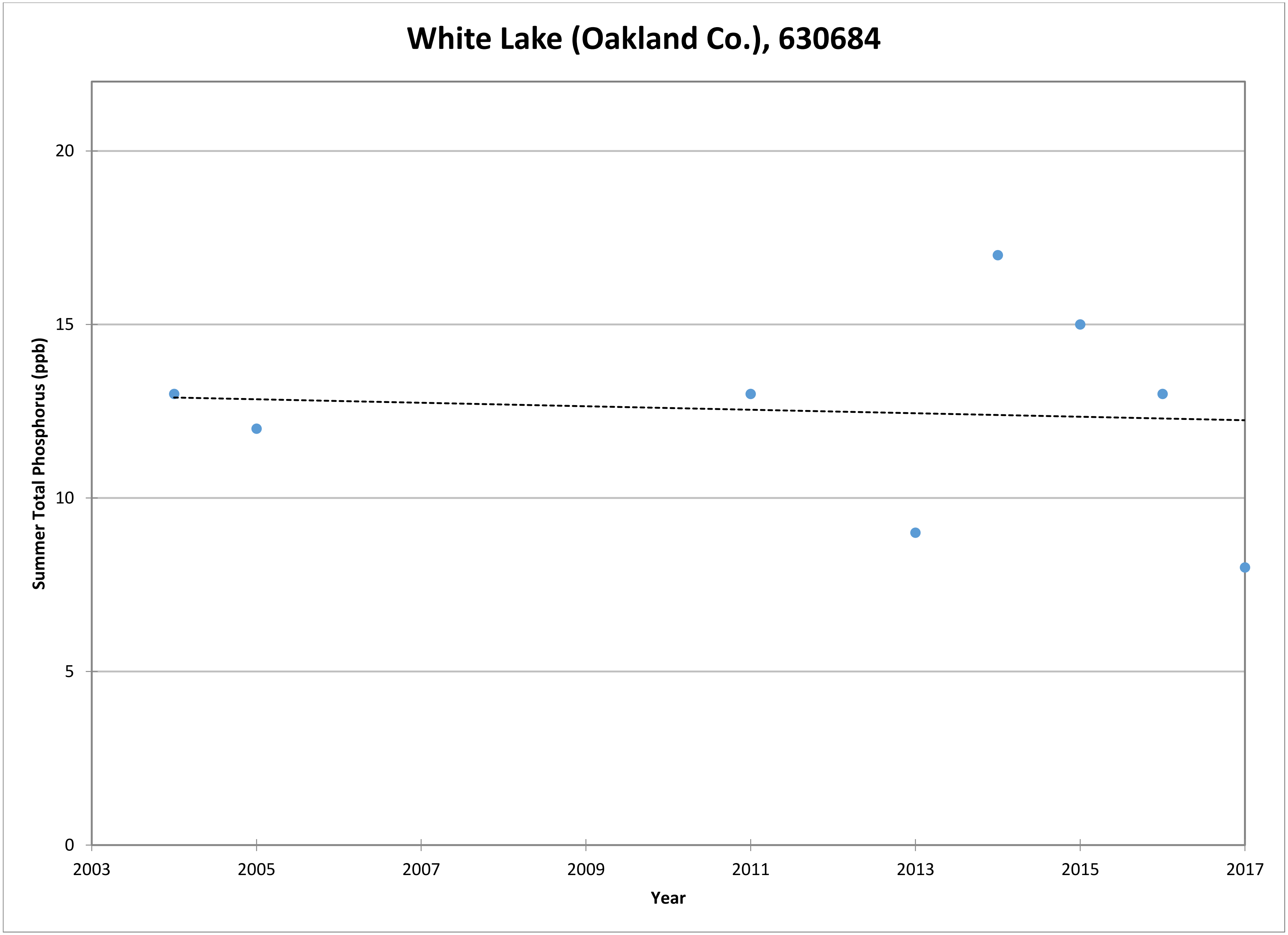


Vertical bars indicate standard deviation

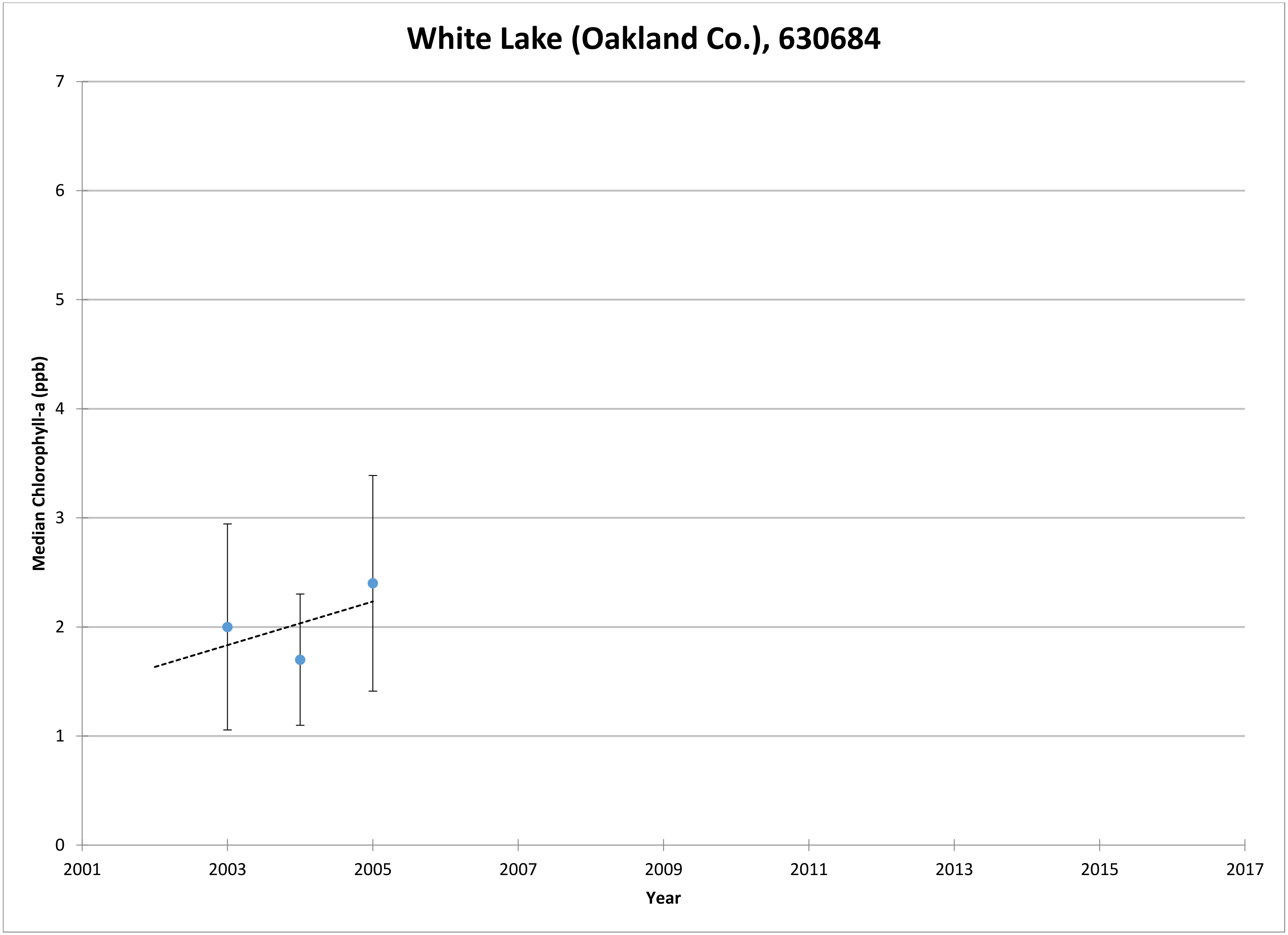
COOPERATIVE LAKES MONITORING PROGRAM
SPRING TOTAL PHOSPHORUS



COOPERATIVE LAKES MONITORING PROGRAM
SUMMER TOTAL PHOSPHORUS



COOPERATIVE LAKES MONITORING PROGRAM
SUMMER MEDIAN CHLOROPHYLL-A



Vertical bars indicate standard deviation

Appendix C
Lake Treatment Reports (2016 – 2018)

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION

CHEMICAL TABLE TEMPLATE FOR TREATMENT OF NUISANCE AQUATIC PLANTS AND/OR ALGAE, OR SWIMMER'S ITCH

Completion of the chemical table template is required by multiple reports in MiWaters. Once complete, upload a copy to the space provided in the associated MiWaters form. Do not alter this template, with the exception of adding additional treatment dates.

ANC Treatment Report:
Upload this chemical table template to the MiWaters treatment report form **no later than November 30**.

ANC Expansion Report:
Upload this chemical table template to the MiWaters expansion report form **within 15 business days after the initial treatment of the expanded area of impact**.

ANC Interim Treatment Report:
Upload this chemical table template to the MiWaters interim treatment report form upon request from the DEQ.

Permittee Information	
Permit Number: ANC9802436 Amendment 1	
Permittee Name: Aqua-Weed Control, Inc.	
Body of Water Treated: White Lake	County: Oakland

Fill in a separate table for each treatment date.
Please note that the assessment of the effectiveness is only required for the treatment report form.

Date of treatment (one date per table): 5-16-16	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Copper Sulfate EPA Reg. #: 46923-4	Surface/Subsurface	4.4 lbs / aft	30	300	Starry Stonewort
Chemical Brand: Sonar One EPA Reg. #: 67690-45	Surface/Subsurface	4 ppb	562	1080 lbs	E. Milfoil
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY WATER RESOURCES DIVISION

CHEMICAL TABLE TEMPLATE FOR TREATMENT OF NUISANCE AQUATIC PLANTS AND/OR ALGAE, OR SWIMMER'S ITCH

Date of treatment (one date per table): 5-18-16	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Copper Sulfate EPA Reg. #: 46923-4	Surface/Subsurface	4.4 lbs / aft	70	600 lbs	Starry Stonewort
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

Date of treatment (one date per table): 6-13-16	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Clipper EPA Reg. #: 59639-161	Surface/Subsurface	1.1 lbs / aft	10	30 lbs	Starry Stonewort
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY WATER RESOURCES DIVISION

CHEMICAL TABLE TEMPLATE FOR TREATMENT OF NUISANCE AQUATIC PLANTS AND/OR ALGAE, OR SWIMMER'S ITCH

Date of treatment (one date per table): 6-23-16	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Copper Sulfate EPA Reg. #: 46923-4	Surface/Subsurface	4.4 lbs / aft	100	900 lbs	Starry Stonewort
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

Date of treatment (one date per table): 6-29-16	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Navigate EPA Reg. #: 228-378-8959	Surface/Subsurface	56.8 lbs / aft	4	500 lbs	E. Milfoil
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY WATER RESOURCES DIVISION

CHEMICAL TABLE TEMPLATE FOR TREATMENT OF NUISANCE AQUATIC PLANTS AND/OR ALGAE, OR SWIMMER'S ITCH

Date of treatment (one date per table): 7-6-16	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Sonar One EPA Reg. #: 67690-45	Surface/Subsurface	2 ppb	562	540 lbs	E. Milfoil
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

Date of treatment (one date per table): 8-3-16	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Sonar One EPA Reg. #: 67690-45	Surface/Subsurface	2 ppb	562	520 lbs	E. Milfoil
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION

CHEMICAL TABLE TEMPLATE FOR TREATMENT OF NUISANCE AQUATIC PLANTS AND/OR ALGAE, OR SWIMMER'S ITCH

Completion of the chemical table template is required by multiple reports in MiWaters. Once complete, upload a copy to the space provided in the associated MiWaters form. Do not alter this template, with the exception of adding additional treatment dates.

ANC Treatment Report:
Upload this chemical table template to the MiWaters treatment report form **no later than November 30**.

ANC Expansion Report:
Upload this chemical table template to the MiWaters expansion report form **within 15 business days after the initial treatment of the expanded area of impact**.

ANC Interim Treatment Report:
Upload this chemical table template to the MiWaters interim treatment report form upon request from the DEQ.

Permittee Information	
Permit Number: ANC9803085	
Permittee Name: Aqua-Weed	
Body of Water Treated: White Lake	County: Oakland

Fill in a separate table for each treatment date.
Please note that the assessment of the effectiveness is only required for the treatment report form.

Date of treatment (one date per table): 5-16-17	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Copper Sulfate EPA Reg. #: 46923-4	Surface/Subsurface	4.4 lbs / aft	70	650 lbs	Starry Stonewort
Chemical Brand: Aquathol-K EPA Reg. #: 70506-176	Surface/Subsurface	1.3–1.9 gal / aft	53	65 gal	Curlyleaf, Potamogetons
Chemical Brand: Renovate 3 EPA Reg. #: 62719-37-67690	Surface/Subsurface	.7 – 2.3 gal / aft	14	40 gal	E.Milfoil
Chemical Brand: Navigate EPA Reg. #: 228-378-8959	Surface/Subsurface	56.8 lbs / aft	14	300 lbs	E. Milfoil
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

CHEMICAL TABLE TEMPLATE FOR TREATMENT OF NUISANCE AQUATIC PLANTS AND/OR ALGAE, OR SWIMMER'S ITCH

Date of treatment (one date per table): 6-15-17	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Copper Sulfate EPA Reg. #: 46923-4	Surface/Subsurface	4.4 lbs / aft	109	1050 lbs	Starry Stonewort
Chemical Brand: Aquathol-K EPA Reg. #: 70506-176	Surface/Subsurface	1.3–1.9 gal / aft	20	20 gal	Curlyleaf, Potamogetons
Chemical Brand: Renovate 3 EPA Reg. #: 62719-37-67690	Surface/Subsurface	.7 – 2.3 gal / aft	14	37.5 gal	E.Milfoil
Chemical Brand: Navigate EPA Reg. #: 228-378-8959	Surface/Subsurface	56.8 lbs / aft	5	500 lbs	E. Milfoil
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

Date of treatment (one date per table): 7-6-17	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Copper Sulfate EPA Reg. #: 46923-4	Surface/Subsurface	4.4 lbs / aft	20	200 lbs	Starry Stonewort
Chemical Brand: Captain EPA Reg. #: 67690-9	Surface/Subsurface	1.2 gal / aft	20	2.5 gal	Starry Stonewort
Chemical Brand: Clipper EPA Reg. #: 59639-161	Surface/Subsurface	1.1 lbs / aft	20	6 lbs	E. Milfoil, Starry, Curlyleaf
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

CHEMICAL TABLE TEMPLATE FOR TREATMENT OF NUISANCE AQUATIC PLANTS AND/OR ALGAE, OR SWIMMER'S ITCH

Date of treatment (one date per table): 7-26-17	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Copper Sulfate EPA Reg. #: 46923-4	Surface/Subsurface	4.4 lbs / aft	31	300 lbs	Starry Stonewort
Chemical Brand: Captain EPA Reg. #: 67690-9	Surface/Subsurface	1.2 gal / aft	31	7.5 gal	Starry Stonewort
Chemical Brand: Clipper EPA Reg. #: 59639-161	Surface/Subsurface	1.1 lbs / aft	10	10 lbs	E. Milfoil, Starry, Curlyleaf
Chemical Brand: Tribune EPA Reg. #: 100-1390	Surface/Subsurface	1 – 2 gal / acre	10	7.5 gal	E.Milfoil, Curlyleaf
Chemical Brand: Aquathol-K EPA Reg. #: 70506-176	Surface/Subsurface	1.3–1.9 gal / aft	10	10 gal	Curlyleaf, Potamogetons
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

Date of treatment (one date per table): 9-7-17	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Clipper EPA Reg. #: 59639-161	Surface/Subsurface	1.1 lbs / aft	4	7 lbs	E. Milfoil, Starry, Curlyleaf
Chemical Brand: Tribune EPA Reg. #: 100-1390	Surface/Subsurface	1 – 2 gal / acre	12	12 gal	E.Milfoil, Niaids
Chemical Brand: Aquathol-K EPA Reg. #: 70506-176	Surface/Subsurface	1.3–1.9 gal / aft	4	4 gal	Curlyleaf, Potamogetons
Chemical Brand: Komeen EPA Reg. #: 67690-25	Surface/Subsurface	3.3 gal / aft	10	85 gal	Eel Grass, Niaids
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION

CHEMICAL TABLE TEMPLATE FOR TREATMENT OF NUISANCE AQUATIC PLANTS AND/OR ALGAE, OR SWIMMER'S ITCH

Completion of the chemical table template is required by multiple reports in MiWaters. Once complete, upload a copy to the space provided in the associated MiWaters form. Do not alter this template, with the exception of adding additional treatment dates.

ANC Treatment Report:
Upload this chemical table template to the MiWaters treatment report form **no later than November 30**.

ANC Expansion Report:
Upload this chemical table template to the MiWaters expansion report form **within 15 business days after the initial treatment of the expanded area of impact**.

ANC Interim Treatment Report:
Upload this chemical table template to the MiWaters interim treatment report form upon request from the DEQ.

Permittee Information	
Permit Number: ANC9803085	
Permittee Name: Aqua-Weed	
Body of Water Treated: White Lake	County: Oakland

Fill in a separate table for each treatment date.
Please note that the assessment of the effectiveness is only required for the treatment report form.

Date of treatment (one date per table): 5-24-18	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:
☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Copper Sulfate EPA Reg. #: 46923-4	Surface/Subsurface	4.4 lbs / aft	109	750 lbs	Macro Algae
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

CHEMICAL TABLE TEMPLATE FOR TREATMENT OF NUISANCE AQUATIC PLANTS AND/OR ALGAE, OR SWIMMER'S ITCH

Date of treatment (one date per table): 5-30-18	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Tribune EPA Reg. #: 100-1390	Surface/Subsurface	1 – 2 gal / acre	90	5 gal	E.Milfoil, Curlyleaf
Chemical Brand: Aquathol-K EPA Reg. #: 70506-176	Surface/Subsurface	1.3–1.9 gal / aft	90	110 gal	Curlyleaf, Potamogetons
Chemical Brand: Renovate 3 EPA Reg. #: 62719-37-67690	Surface/Subsurface	.7 – 2.3 gal / aft	90	180 gal	E.Milfoil
Chemical Brand: Navigate EPA Reg. #: 228-378-8959	Surface/Subsurface	56.8 lbs / aft	15	1600 lbs	E. Milfoil
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

Date of treatment (one date per table): 6-28-18	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Tribune EPA Reg. #: 100-1390	Surface/Subsurface	1 – 2 gal / acre	7.5	7.5 gal	E.Milfoil, Curlyleaf
Chemical Brand: Copper Sulfate EPA Reg. #: 46923-4	Surface/Subsurface	4.4 lbs / aft	40	400 lbs	Macro Algae
Chemical Brand: Captain EPA Reg. #: 67690-9	Surface/Subsurface	1.2 gal / aft	40	5 gal	Macro Algae
Chemical Brand: Clipper EPA Reg. #: 59639-161	Surface/Subsurface	1.1 lbs / aft	5	5 lbs	E. Milfoil, Starry, Curlyleaf
Chemical Brand: Cygnet Plus EPA Reg. #: N/A	Surface/Subsurface	2.5 pints / aft	40	8 pts	Adjuvant
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

CHEMICAL TABLE TEMPLATE FOR TREATMENT OF NUISANCE AQUATIC PLANTS AND/OR ALGAE, OR SWIMMER'S ITCH

Date of treatment (one date per table): 8-23-18	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Tribune EPA Reg. #: 100-1390	Surface/Subsurface	1 – 2 gal / acre	30	30 gal	E.Milfoil, Curlyleaf
Chemical Brand: Aquathol-K EPA Reg. #: 70506-176	Surface/Subsurface	1.3–1.9 gal / aft	30	32.5 gal	Curlyleaf, Potamogetons
Chemical Brand: Clipper EPA Reg. #: 59639-161	Surface/Subsurface	1.1 lbs / aft	30	15 lbs	E. Milfoil, Starry, Curlyleaf
Chemical Brand: Komeen EPA Reg. #: 67690-25	Surface/Subsurface	3.3 gal / aft	9	70 gal	Eel Grass, Niaids
Chemical Brand: Harpoon (G) EPA Reg. #: 8959-55	Surface/Subsurface	40 – 80 lbs / aft	2	320 lbs	Eel Grass
Chemical Brand: Cygnet Plus EPA Reg. #: N/A	Surface/Subsurface	2.5 pints / aft	30	40 pts	Adjuvant
Chemical Brand: EPA Reg. #:					

Date of treatment (one date per table): 8-30-18	Name of person applying chemical: Dick Pinagel	Name of Company: Aqua-Weed Control, Inc.

Effectiveness:

☐ Good (70 - 100%) x Fair (50 - 69%) ☐ Poor (less than 50%) ☐ Ineffective (0%)

CHEMICAL USED	METHOD OF APPLICATION	RATE OF APPLICATION (ex. 100 lbs/acre, 2.6 lbs/acre –foot)	ACTUAL TREATMENT AREA SIZE (acres)	TOTAL AMOUNT (ex. 4 gallons, 10 lbs.	FOR CONTROL OF: (Plant and/or Algae names)
Chemical Brand: Aquathol-K EPA Reg. #: 70506-176	Surface/Subsurface	1.3–1.9 gal / aft	3	2 gal	Curlyleaf, Potamogetons
Chemical Brand: Harpoon (G) EPA Reg. #: 8959-55	Surface/Subsurface	40 – 80 lbs / aft	3	240 lbs	Eel Grass
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					
Chemical Brand: EPA Reg. #:					

CHEMICAL TABLE TEMPLATE FOR TREATMENT OF NUISANCE AQUATIC PLANTS AND/OR ALGAE, OR SWIMMER'S ITCH

Appendix D
Fisheries Data

Fisheries Division
Lake Erie Management Unit

Fisheries Survey
White Lake
Spring 2007

Water: **White Lake**
T/R/S: 03N 07E Sec 12,13
Primary County: Oakland
Watershed: Huron River
Status: Approved
Survey begin: 05/21/2007 End: 06/05/2007
Special Regs: None
Purpose: General Survey and Walleye Stocking Evaluation

Gear Types

Gear type: Trap Net
Effort date range: 05/21/2007 – 05/24/2007
No. of gear used: 4
Effort quantity: 12 Net Nights
Depth range: 0-8 feet
Temperature range: 62-71

Gear type: Gill Net
Effort date range: 05/21/2007 – 05/22/2007
No. of gear used: 1
Effort quantity: 1 Net Nights
Depth range: 13-22 feet
Temperature range: 62-65.7

Gear type: Minnow Seine
Effort date range: 05/23/2007 – 05/23/2007
No. of gear used: 1
Effort quantity: 3 Hauls
Depth range: 0-3 feet
Temperature range: 70-71

Gear type: Boom Shocker
Effort date range: 06/05/2007
No. of gear used: 1
Effort quantity: 3, 10-minute transects
Depth range: 1-6 feet
Temperature range: 71

Gear type: Limnology
Effort date range: 08/08/2007
Depth range: 0-28 feet
Temperature range: 80.6-66.2

Collection by: LEMU
Identification by: LEMU
Analysis by: Braunscheidel

Date approved: November 13, 2009

Lake Description:

White Lake is a 540-acre natural lake located in west-central Oakland County approximately 12 miles west of the City of Pontiac. It has an average depth of 12 feet with a maximum depth of 32 feet and is divided into roughly two large basins. A large portion of the southern basin is greater than 20 feet deep. There is a total of approximately 39,000 linear feet (7.4 miles) of shoreline as measured during shoreline sampling in July of 2005 that divided the shoreline into 38 survey segments (most 1,000 ft long).

The lake shoreline is almost totally developed into residential lots with 66% of the shoreline armored in some fashion. A total of 21 survey segments had 90% or more of the shoreline armored. Shoreline habitat observations conducted around the entire lake shoreline in July of 2005 counted 420 docks, 413 dwellings, and 75 submerged trees (see shoreline sampling report). The lake is heavily used for all types of water-based recreational activities including extensive fishing. There is a DNR public boat access on the southwest corner of the lake off Duck Lake Road about ½ mile north of M-59.

Dissolved oxygen profiles from 1997 and earlier years show a lack of adequate oxygen to support fish below 22-25 feet. A profile taken on August 8, 2007, showed a weak thermocline established at 18-20 feet. Water temperatures were fairly constant (79-81^{0}F) down to 16 feet, then gradually dropped down to 66^{0}F by 28 feet. Dissolved oxygen was constant at just over 9 ppm down to 18 feet then dropped sharply at the thermocline down to 1.1 ppm at 22 feet and 0.3 ppm below 26 feet. Water clarity is generally good in this lake with Secchi disk readings of 10-12 feet or more common through the summer. A Secchi reading of 22.0 ft was obtained during limnology sampling on August 8, 2007. Chemical analysis of water samples obtained on this same date found total phosphorus at 9 ug/l, total nitrogen at 420 ug/l, ammonia nitrogen at 6 ug/l, nitrate+nitrite nitrogen at 3 ug/l, and Chlorophyll a at 3.6 ug/l.

History:

The lake has historically been a warm-water fishery, but walleye (a cool-water species) have been regularly stocked since 1980 (see stocking history report). Low numbers of walleye fingerlings were stocked most years from 1980 through 1988 and a higher density (50-100/acre) stocking program that began in 1989 continues on a biennial basis with the last stocking conducted in 2006. White Lake has a reputation as a good fishing lake for largemouth bass and northern pike with many reports of walleyes being caught the past few years. Angler reports put the panfish fishery as fair to good for bluegills, sunfish and crappies.

Due to heavy aquatic vegetation growth in the lake, it has been treated with various chemicals over the years and large portions of the lake are treated on an annual basis with various chemicals. The chemical “Fluridone” was used at a relatively high concentration (20ppb) in 1992 to help control the excessive Eurasian milfoil growths that were a major problem in the lake and this resulted in a significant reduction in all submerged vegetation for that year and the next. Fluridone was also applied in 1999, 2000, 2003 and 2008 at rates from 6-8ppb. Copper sulfate for algae control has been used every year and a variety of other chemicals were, and continue to be applied to large portions of the shallow areas of the lake in the years between fluridone treatments to control nuisance aquatic vegetation.

Fisheries surveys were conducted in 1995 and 1997 to collect post-treatment data to evaluate potential impacts on the fish community from the fluridone treatment. These surveys seemed to document negative impacts on the 1992 year classes of panfish in White Lake, but also showed that, over time, these species appeared to be compensating for these impacts.

Survey Purpose and Description:

This survey was conducted both as a general fish community survey and an evaluation of the walleye stocking program in White Lake. Sampling gear used for the survey included 4 standard inland trap nets, 1 experimental gill net, a boom shocker, and a 25-foot seine. From May 21 through May 24, 2007, the trap nets were set for three nights, the gill net for 1 night, and three seine hauls were conducted. Electroshocking of three, 10-minute transects was conducted with the boom shocker during the night of June 5, 2007.

Survey Results:

General
A total of 1,569 fish comprised of 21 species weighing an estimated 642 pounds were collected during this 2007 survey. Panfish such as black crappie, bluegill, hybrid sunfish, longear sunfish, pumpkinseed sunfish, and warmouth made up 71% of the total catch by number and 22% by weight. Large game fish, including largemouth bass, smallmouth bass, northern pike and walleye, comprised almost 6% of the total catch by number and 26% by weight. Rough fish (large, non-game species) such as bowfin, carp and redhorse sucker made up 2% of the total catch by number and 18% by weight. Bullheads (black and brown) were fairly abundant making up over 19% of the total catch by number and 34% by weight. See the catch summary tables for details on all species collected in this survey.

Panfish
Bluegill were the most abundant panfish with the 719 individuals caught accounting for 46% of the total survey catch by number and 6% by weight. The trap net catch (174 fish) averaged 5.6 inches in length with 34% (60 fish) exceeding the minimum size acceptable to anglers of 6 inches and 2 fish exceeding 8 inches. Catch per unit of effort (CPE) of the trap net catch was low compared to other lakes in the area with only 14.5 fish caught per net lift. While this catch rate is similar to that found in the previous survey conducted in 1997, the average fish size was smaller with fewer fish exceeding the angler preferred size and the 8-inch mark (see summary table below). Those bluegill caught in the electrofishing samples averaged only 3.3 inches. Growth was poor with a mean growth index 1.6 inches below state average based on length-at-age data from scale and spine samples.

Bluegill Data Summary Table

Year	Avg TN Length	Avg ES Length	% >6 inches	TN CPE	Growth Index	Schneider Index
1986	5.4	---	14%	14.9	-0.9	1.25
1993	6.1	---	57%	58.6	-0.9	2.5
1995	7.1	3.2	98%	60.3	-0.8	4.7
1997	7.2	4.7	94%	11.6	-0.8	5.7
2007	5.6	3.3	34%	14.5	-1.6	3.0

The quality of the bluegill population in White Lake was also evaluated using Schneider's Index (Schneider 1990). This index provides a ranking system that describes the quality of a bluegill population in a lake using a scale of 1 to 7 primarily based on the percent of bluegill in the trap net catch in the 6, 7, and 8-inch size ranges (Schneider 1990). The index calculated for White Lake based on the trap net catch from this survey is 3.0 which corresponds to an "acceptable" rating. This is significantly lower than the index from the two previous surveys and is a reversal of the increasing index trend shown in the data summary table.

Panfish (continued)
The second most abundant panfish in this survey was the **pumpkinseed sunfish**. They accounted for 14% of the total catch by number and 8% by weight with an average length in the trap net catch of 6.6 inches. Over 74% exceeded the minimum size acceptable to anglers of 6 inches with five fish exceeding 8 inches. Growth rates were fair with a mean growth index 0.3 inches below the state average based on length-at-age data from spine and scale samples. While pumpkinseed sunfish were slightly more abundant than in previous surveys, the average size and growth was similar to the 1995 and 1997 surveys.

Black crappies were historically much more abundant than found in this 2007 survey. Trap nets caught only 56 crappie in this 2007 survey (CPE of 5 fish per net lift) compared to 250-350 fish in the 1995 and 1997 surveys (CPEs of 29 and 16 fish per net lift, respectively). Growth was better than these previous surveys with a mean growth index of -0.5 in 2007 compared to growth indices of -1.5 in 1995 and -0.7 in 1997. Average length and size distributions were similar in all three surveys.

Other panfish caught during this 2007 survey included 29 longear sunfish (1-4 inches), 27 rock bass (2-12 inches), 26 warmouth (2-9 inches), and 20 hybrid sunfish (2-8 inches). A few yellow perch and one green sunfish were also collected.

Large Game Fish
The most abundant large game fish species collected was **largemouth bass**. They comprised just over 3% of the total catch by number and 12% by weight with an average length of 14.1 inches in the trap net catch. An unusually high proportion of the catch (60%, 26 of 43 fish) exceeded the minimum legal size limit of 14 inches. Growth was good with a mean growth index 1.0 inches above the state average. All year classes from Age II through Age XI were present in the fish collected. The percentage of legal size largemouth bass and growth rate were better in this survey compared to the 1995 and 1997 surveys.

Northern pike were also fairly abundant in the catch from this survey. A total of 18 pike ranging from 9 to over 25 inches were collected with an overall average length of 21.7 inches and 7 fish exceeding the minimum legal size limit of 24 inches. While not enough fish were collected for a significant growth analysis, the data indicates they were growing 1-2 inches below state average which is similar to the growth information from previous surveys.

Walleye numbers were down a little compared to previous surveys. The 12 walleye caught represented a trap net CPE of 1.0 in this 2007 survey compared to catch rates of 2.7 and 2.4 in the 1995 and 1997 surveys. They averaged almost 21 inches in this survey with all of them exceeding the minimum legal size limit of 15 inches. The youngest walleye collected were 5-year olds corresponding to the 2002 stocking. Most of the other fish caught also matched years where stocking occurred. The consistent matching of walleye caught with years stocked in survey results indicates there is no significant natural reproduction occurring in White Lake.

Smallmouth bass are also present in White Lake. Surveys consistently catch small numbers of this species (2-10 fish) with some legal sized fish (over 14 inches) usually present.

Rough Fish
There are significant numbers of large, non-game fish species present in the lake. Combined they represented over 18% of the total survey catch by weight. **Carp** were common in White Lake with the 22 caught in this survey ranging from 14 to 35 inches and comprising 15% of the total survey catch by weight. **Bowfin** were also present with 6 individuals ranging from 19-23 inches. A single **golden redhorse sucker** was captured at a length of 18 inches.

Miscellaneous Fish and Turtles

The catch of small, forage type fish species was not representative of their actual abundance in White Lake. While only 39 minnow-like fish were captured, schools were observed swimming in the lake during this survey and other visits to the lake. Species actually caught in this survey included 34 **banded killifish**, 3 **bluntnose minnow**, and 2 **blackchin shiner**.

Similar to previous surveys, **black** and **brown bullhead** were abundant in the survey catch. Together they comprised over 19% of the total catch by number and almost 34% by weight with an average length over 11 inches. Only 14 of the 304 collected were less than the minimum size acceptable to anglers of 10 inches with 75 bullheads exceeding 12 inches.

Turtles observed in the sampling gear during the survey included 18 **musk turtles** (3-5 inches), 1 **snapping turtle** (12 inches), 1 **painted turtle** (5 inches), and 3 **spiny softshell turtles** (8-13 inches).

Conclusions and Management Recommendations:

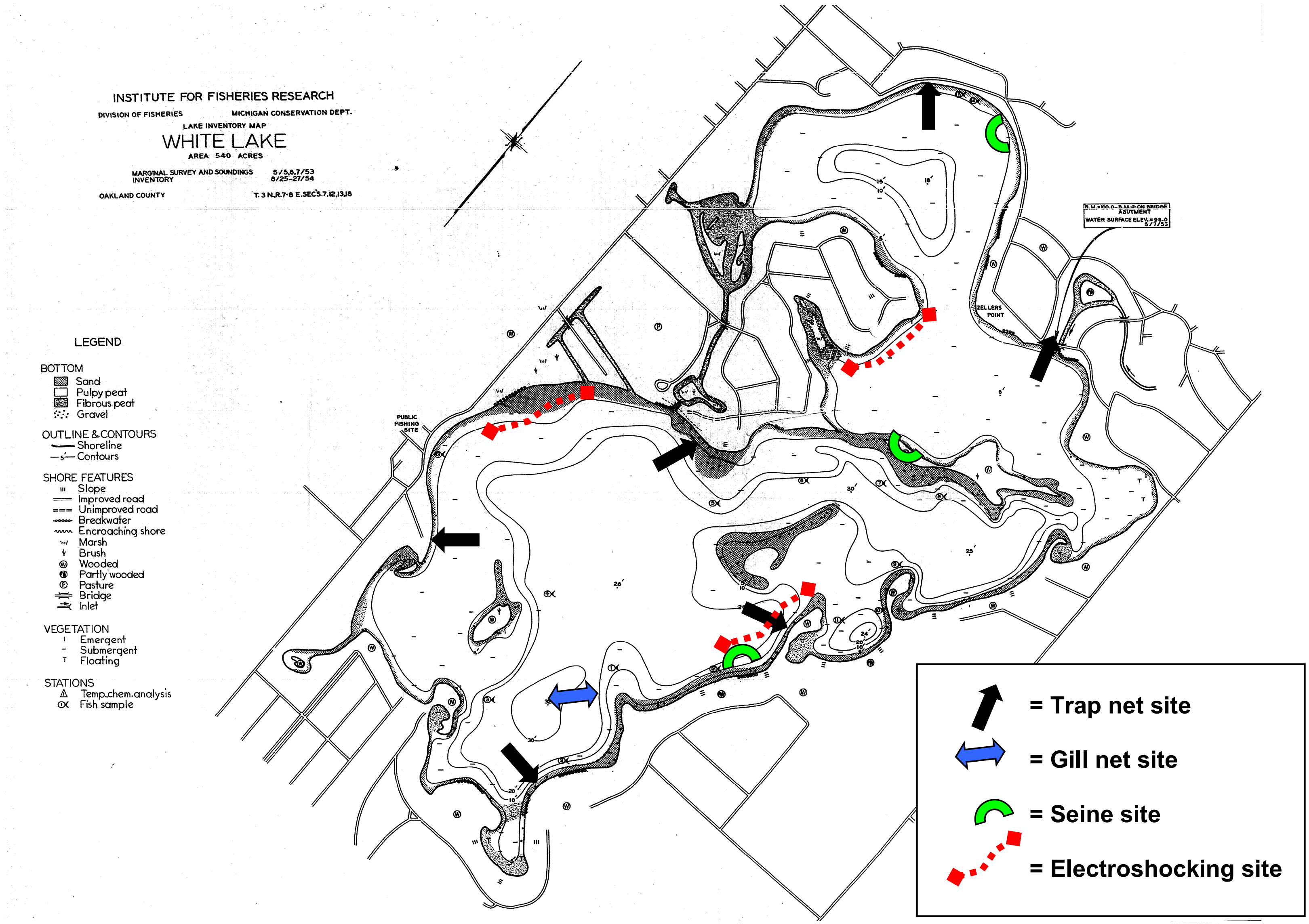
This 2007 survey indicates that in the ten year period since the last survey, the panfish fishery in White Lake has declined significantly in quality compared to what had been a steadily improving population in the mid-1990s. Both sizes and numbers of bluegill and black crappie have declined since the 1997 survey. The walleye stocking frequency and density has been steady through this entire period and the largemouth bass and northern pike populations continue to be healthy. Thus, a lack of predators is not the problem. Something else is affecting both panfish recruitment and growth to larger sizes.

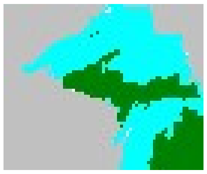
Human impacts on a lake ecosystem can be significant. Heavy levels of shoreline development result in a decreased quality of near shore and other shallow water habitats that are crucial to the health of fish communities. Activities such as shoreline alterations that include armoring and dredging, along with removal of large woody material and chemical treatments for vegetation control, all act to reduce both the food and habitat needed by smaller fish species such as panfish and minnows (O'Neal 2006). Artificially reducing the natural algae in a lake can affect the zooplankton which feed on algae. Since bluegill and other panfish species utilize zooplankton as their primary food source at small sizes, reducing the zooplankton food base can impact their populations. The consistent, large scale chemical treatments to control algae in White Lake could very well be a significant factor in the decline of panfish noted above. Selective harvest of larger panfish can also be a factor when fishing pressure is high.

The shoreline sampling conducted for this survey documents the high level of shoreline development (413 dwellings on the lake), the large percentage of shoreline that has been altered (overall 66% armored with more than half the shoreline segments having 90% of the shore armored), and the scarcity of large woody material in much of the lake's shallow water areas (the 75 trees counted were all located in just 10 of the 37 shoreline sections). Fishing and boating pressure on the lake is also very heavy (420 docks counted).

The largemouth bass and northern pike in White Lake are doing well despite the heavy fishing pressure and altered near-shore habitat. These species tend to utilize deeper areas for much of their life, although the proper shallow habitat is needed for reproduction. Walleye continue to be a significant part of the fishery as well, although their presence depends on continuing the stocking program since natural reproduction is not occurring. *No change in the management of these larger game fish is needed at this time. The bi-annual stocking of walleye fingerlings should continue at current levels.*

2007 SAMPLING LOCATIONS





WHITE LAKE, OAKLAND COUNTY
Fisheries Survey
April 3-22, 2013

Lake Description:

White Lake is a 540-acre natural lake located in west-central Oakland County approximately 12 miles west of the City of Pontiac (Figure 1). It has an average depth of 12 feet with a maximum depth of 32 feet and is divided into roughly two large basins. A large portion of the southern basin is greater than 20 feet deep.

There is a total of approximately 39,000 linear feet (7.4 miles) of shoreline as measured during shoreline sampling in July 2005 that divided the shoreline into 38 survey segments (most 1,000 feet long). The lake shoreline is almost totally developed into residential lots with 66% of the shoreline armored in some fashion. A total of 21 survey segments had 90% or more of the shoreline armored. Shoreline habitat observations conducted around the entire lake shoreline counted 420 docks, 413 dwellings, and 75 submerged trees (see 2005 shoreline sampling report in Fish Division files). The lake is heavily used for all types of water-based recreational activities including extensive fishing. There is a DNR public boat access on the southwest corner of the lake off Duck Lake Road about a half mile north of M-59.

Dissolved oxygen profiles from 1997 and earlier years show a lack of adequate oxygen to support fish below 22-25 feet. A profile taken on August 8, 2007, showed a weak thermocline established at 18-20 feet. Water temperatures were fairly constant (79-81^0F) down to 16 feet, then gradually dropped down to 66^0F by 28 feet. Dissolved oxygen was constant at just over 9 ppm down to 18 feet then dropped sharply at the thermocline down to 1.1 ppm at 22 feet and 0.3 ppm below 26 feet. Water clarity is generally good in this lake with Secchi disk readings of 10-12 feet or more common through the summer. A Secchi disk reading of 22.0 feet was obtained during limnology sampling on August 8, 2007.

History:

The lake has historically been a warm-water fishery, but walleye, a cool-water species, have been regularly stocked since 1980. Low numbers of walleye fingerlings were stocked most years from 1980 through 1988 and a higher density (50-100/acre) biennial stocking program has been in place from 1991 through 2012 (Table 1). White Lake has a reputation as a good fishing lake for largemouth bass and northern pike with many reports of walleyes being caught as well. Angler reports put the panfish fishery as fair to good for bluegills, sunfish, and crappies.

Table 1. White Lake Walleye Stocking Summary

Year	1991	1993	1995	1996	1998	2000	2002	2004	2006	2009	2010	2011	2012
No. Stocked	25,117	31,661	28,573	53,329	50,796	53,298	40,128	54,489	50,128	42,807	40,807	12,415	40,585
No./Acre	47	59	53	99	94	99	74	101	93	79	76	23	75
Size (inches)	3.2	2.25	2.12	1.7	1.55	1.3	2	1.1	1.1	1.32	1.86	1.84	1.27

Due to heavy aquatic vegetation growth in the lake, it has been treated with various chemicals over the years and large portions of the lake are treated on an annual basis with various chemicals. The chemical "Fluridone" was used at a relatively high concentration (20ppb) in 1992 to help control excessive Eurasian milfoil growths that were a major problem and this resulted in a significant reduction in all submerged vegetation for that year and the next. Fluridone was also applied in 1999, 2000, 2003, and 2008 at rates from 6-8ppb. Copper sulfate for algae control has been used every year and a variety of other chemicals were, and continue to be applied to large portions of the shallow areas in the years between fluridone treatments, to control nuisance aquatic vegetation.

Fisheries surveys were conducted in 1995 and 1997 to collect post-treatment data to evaluate potential effects on the fish community from the fluridone treatment. These surveys documented negative effects on the 1992 year classes of panfish in White Lake, but also showed that, over time these species appeared to be compensating.

Survey Purpose and Description:

This survey was conducted to evaluate the success of the walleye stocking program in White Lake and determine a population estimate for walleye and northern pike. Six trap nets were set at various locations around the lake over a total of 18 nights (108 net nights) with 9 lifts of each net during the period from April 4 through April 22, 2013. Length data was collected for all walleye, northern pike, largemouth and smallmouth bass that were caught. Scale or spine samples for age analysis were collected from all walleye and northern pike. All walleye over the legal-size limit of 14 inches and all northern pike received a fin clip for recapture determinations and population estimate calculations.

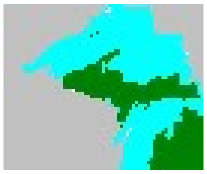
Survey Results:

A total of 11 smallmouth bass, 124 largemouth bass, 60 walleye, and 387 northern pike were caught. Five walleye and 47 northern pike were recaptures.

Smallmouth bass ranged from 11 up to 20 inches long with 7 of 11 exceeding the minimum legal-size limit of 14 inches. **Largemouth bass** ranged from 10 up to 19 inches with 110 of 124 over the minimum legal-size limit of 14 inches.

The 55 **walleye** collected ranged from 14 up to 27 inches long with an average length of 21.6 inches. All except one were over the minimum legal-size limit of 15 inches. Ageing results found 7 age classes represented in the catch from age 3 up to age 16 with a mean growth index 0.6 inches above the state average. Catch rates were standardized as number of fish caught per net night since the nets were set anywhere from 1 to 3 nights between lifts. The overall catch rate for walleye was 0.56 fish per net night. The population estimate based on the Schumacher/Eschmeyer method (Figure 2) is 283 adult walleye or about 0.5 walleye per acre.

An early spring walleye population survey, similar to this survey, was conducted in 1998. The walleye catch rate was much higher at 6.8 fish per net night and the population estimate was also higher at 825 adult walleye or 1.5 walleye per acre. Growth was good with the mean growth index 1.4 inches above state average.



The 340 **northern pike** caught ranged from 16 up to 28 inches long with an average length of 21.5 inches and 45 fish exceeding the minimum legal-size limit of 24 inches. All age groups from age 3 through age 8 were identified from the ageing process with significant numbers present in each age. Growth overall was slow with a mean growth index 2.9 inches below the state average. The overall catch rate for northern pike was 3.58 fish per net night. The population estimate based on the Schumacher/Eschmeyer method (Figure 3) is 1,770 adult northern pike or about 3.3 pike per acre.

A population survey conducted in the spring of 1998 did not produce a population estimate for northern pike due to a lack of recaptures, but the trap net catch rate of 1.6 fish per net night was much lower than this survey. Growth was also fairly slow in 1998 with a mean growth index 1.7 inches below the state average. All year classes from age 2 through age 11 were present.

Conclusions and Management Recommendations:

1. The population of largemouth bass is doing very well with a high percentage of fish meeting the legal-size limit. Angling reports also support this with the number of legal bass caught reported to be excellent by local angling groups. No management actions are needed with respect to this species.

2. The walleye population estimate of 283 adult fish (0.5 walleye per acre) is somewhat below what is usually considered adequate to produce a fair walleye fishery in other lakes in Southeast Michigan. Adult walleye densities of at least 1 fish per acre are found in other area lakes that support walleye fishing. Despite a fish density lower than other area walleye lakes, and a much lower population estimate compared to the 1998 survey, anglers do report catching enough to bring them back to this lake.

3. Comparing the walleye stocking history (Table 1) with the fish ages found in this survey shows that almost every stocked year class was represented in the survey. This indicates consistent survival of the stocked fingerlings despite the smaller size at stocking for most years after 1998. Stocking of walleye spring fingerlings should continue at the current level of 75-100/acre every other year if fingerlings are less than 1.7 inches. The higher survival rates of fingerlings over 1.7 inches (see 1998 survey report in Fish Division files) would allow stocking at a lower level of 50/acre.

4. The northern pike population estimate of 3.3 adult fish per acre shows there is an excellent population of this species present. Consistently successful spawning and recruitment is occurring in White Lake despite the high level of shoreline development. The overall pike density, along with an average of about 1 legal-size pike per acre, is enough to classify White Lake as one of the better northern pike fisheries in the Lake Erie Management Unit. No management actions are needed other than to continue advocating for responsible management of fish habitat in the lake.

Survey Report by: Jeffrey Braunscheidel
Senior Fisheries Biologist

Date Completed: June 24, 2014

Figure 1. Location and lake map of White Lake, Oakland County.

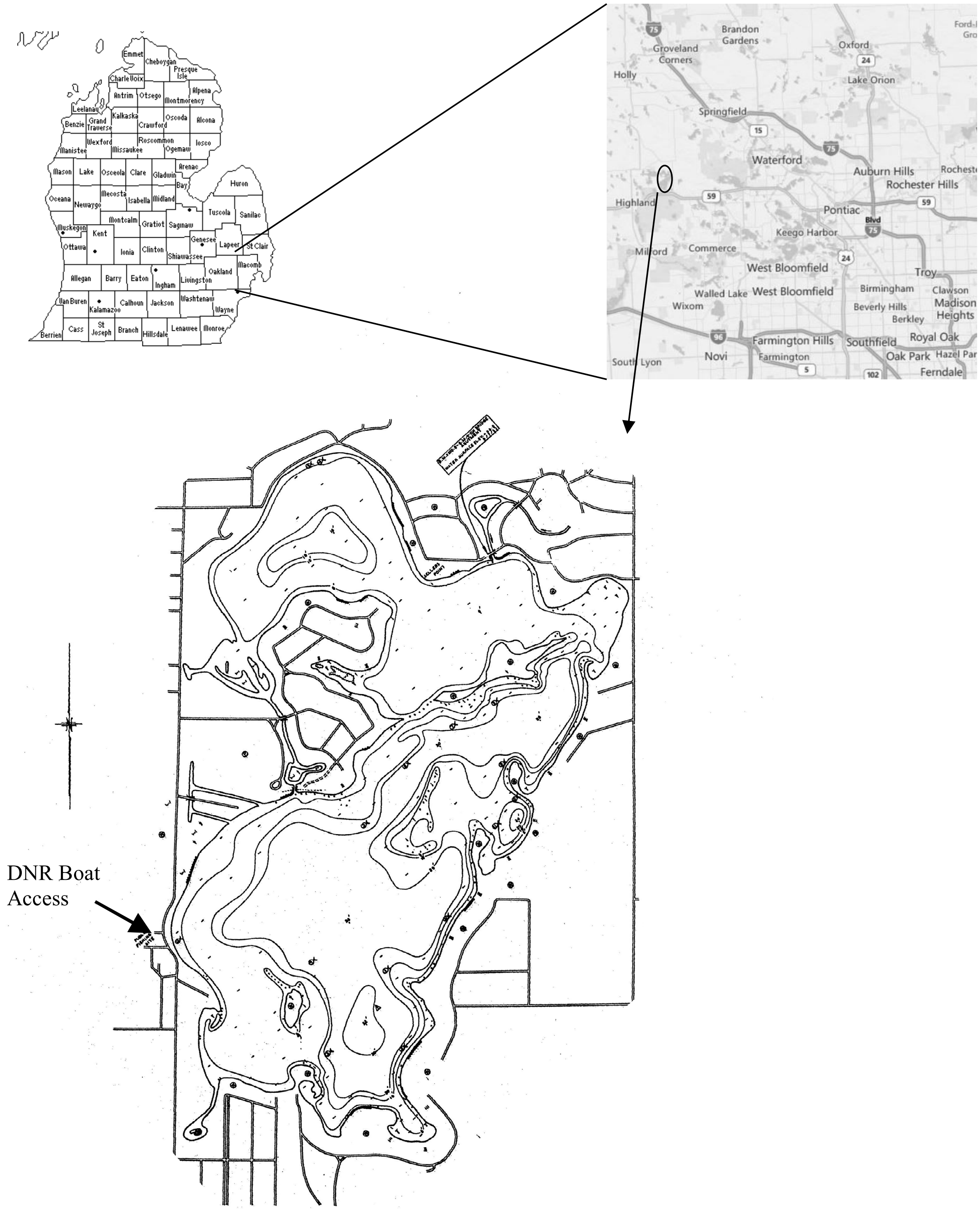


Figure 2. Walleye population estimate data and results for 2013 White Lake survey.

Day	*C* (total # caught)	*U* (# unmarked)	*R* (# recaps)	*M* (marked in pop)	*R x M*	*C x M^2*	*R^2/C*
April 4, 2013	9	9	0		0	0	0
April 5, 2013	11	11	0	9	0	891	0
April 8, 2013	14	14	0	20	0	5600	0
April 10, 2013	5	5	0	34	0	5780	0
April 12, 2013	7	7	0	39	0	10647	0
April 15, 2013	11	8	3	46	138	23276	0.818181818
April 17, 2013	4	3	1	54	54	11664	0.25
April 19, 2013	3	2	1	57	57	9747	0.333333333
April 22, 2013	1	1	0	54	0	2916	0
				55	249	70521	1.401515152

Schumacher/Eschmeyer

$$N = \frac{\sum_{d=1}^{n} C_d M_d^2}{\sum_{d=1}^{n} R_d M_d}$$

# of samples =	9		
variance (s^2) =	0.065291278		
1/N =	0.003530863		
variance of 1/N	9.25842E-07		
SE of 1/N =	0.000962207		
95% limits (+/-)	0.002218853		
Lower 1/N C.L.	0.005749716		
Upper 1/N C.L.	0.001312011		
CV =	0.272513154		
N =	**283**	Lower asym C.L.	**174**
Lake acreage =	540	Upper asym C.L.	**762**
Density =	**0.5**		

Enter data in green cells

Estimates are in orange cells

Figure 3. Northern Pike population estimate data and results for 2013 White Lake survey.

Day	*C* (total # caught)	*U* (# unmarked)	*R* (# recaps)	*M* (marked in pop)	*R x M*	*C x M^2*	*R^2/C*
April 4, 2013	109	109	0		0	0	0
April 5, 2013	49	44	5	109	545	582169	0.510204082
April 8, 2013	115	99	16	153	2448	2692035	2.226086957
April 10, 2013	46	35	11	252	2772	2921184	2.630434783
April 12, 2013	35	27	8	287	2296	2882915	1.828571429
April 15, 2013	51	45	6	314	1884	5028396	0.705882353
April 17, 2013	18	18	0	359	0	2319858	0
April 19, 2013	10	10	0	377	0	1421290	0
April 22, 2013	3	2	1	359	359	386643	0.333333333
				361	10304	18234490	8.234512936

Schumacher/Eschmeyer

$$N = \frac{\sum_{d=1}^{n} C_d M_d^2}{\sum_{d=1}^{n} R_d M_d}$$

# of samples =	9		
variance (s^2) =	0.301487235		
1/N =	0.000565083		
variance of 1/N	1.65339E-08		
SE of 1/N =	0.000128584		
95% limits (+/-)	0.000296516		
Lower 1/N C.L.	0.000861599		
Upper 1/N C.L.	0.000268567		
CV =	0.227549259		
N =	**1770**	Lower asym C.L.	**1161**
Lake acreage =	540	Upper asym C.L.	**3723**
Density =	**3.3**		

Enter data in green cells

Estimates are in orange cells

Water	White Lake T03N R07E S12							
Survey	05/21/2007-06/05/2007							
Gear	All Gear combined							
Effort meas.	Various							
Species	Black bullhead		Black crappie		Blackchin shiner		Bluegill	
Legal size (in)	>=7.00		>=7.00		>=		>=6.00	
Avg. length (in)	11.7		9.2		2.0		3.6	
Avg. weight (lb)		0.77		0.52		0.00		0.04
	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.
Total	91	69.77	33	17.03	2	0.00	590	22.09
No. legal	91		26		0		19	
% Legal size	100.00%		78.79%				3.22%	
% Total catch	8.62%	23.42%	3.13%	5.72%	0.19%	0.00%	55.87%	7.42%
CPE								
Inch group								
0								
1					1		1	
2					1		149	1.36
3							295	7.83
4			2	0.08			94	5.54
5							32	3.54
6			5	0.7			17	3.22
7			4	0.89			2	0.6
8	1	0.3	4	1.33				
9	2	0.82	4	1.89				
10	11	6.01	8	5.22				
11	46	32.63	2	1.74				
12	23	20.74	2	2.28				
13	7	7.89	2	2.9				
14	1	1.38						
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
Sample total:	91	69.77	33	17.03	2	0.00	590	22.09
Effort date(s):	Various							
All species total:		Number:	1,056	Pounds:	297.90			
	North Basin,	uth of canals	East shorelin	boat launch	North shoreli	South side of	East shore, c	Northeastern

Water	White Lake T03N R07E S12							
Survey	05/21/2007-06/05/2007							
Gear	All Gear combined							
Effort meas.	Various							
Species	Bluntnose minnow		Bowfin		Brown bullhead		Common carp	
Legal size (in)	>=		>=		>=7.00		>=	
Avg. length (in)	2.2		21.3		11.2		17.1	
Avg. weight (lb)		0.01		3.47		0.68		2.54
	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.
Total	3	0.02	5	17.35	55	37.16	8	20.29
No. legal	0		0		54		0	
% Legal size					98.18%			
% Total catch	0.28%	0.01%	0.47%	5.82%	5.21%	12.47%	0.76%	6.81%
CPE								
Inch group								
0								
1	2							
2								
3	1	0.02						
4					1	0.05		
5								
6								
7								
8								
9					4	1.64		
10					18	9.82		
11					19	13.48		
12					11	9.92		
13					2	2.25		
14							1	1.53
15							2	3.7
16							1	2.21
17							2	5.22
18								
19			2	5.28			1	3.54
20							1	4.09
21								
22			3	12.07				
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
Sample total:	3	0.02	5	17.35	55	37.16	8	20.29
Effort date(s):								
All species total:								
	Southeasterr	Southwest sl	East shorelin	Northeastern	Southeastern area of lake			

Water	White Lake T03N R07E S12							
Survey	05/21/2007-06/05/2007							
Gear	All Gear combined							
Effort meas.	Various							
Species	Golden redhorse		Green sunfish		Hybrid Sunfish Hybrid		Killifishes (Family)	
Legal size (in)	>=		>=6.00		>=6.00		>=	
Avg. length (in)	18.5		5.5		5.6		1.7	
Avg. weight (lb)		2.21		0.12		0.15		0.00
	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.
Total	1	2.21	1	0.12	14	2.10	34	0.00
No. legal	0		0		7		0	
% Legal size			0.00%		50.00%			
% Total catch	0.09%	0.74%	0.09%	0.04%	1.33%	0.70%	3.22%	0.00%
CPE								
Inch group								
0								
1							26	
2					1	0.01	8	
3								
4					3	0.19		
5			1	0.12	3	0.36		
6					6	1.22		
7					1	0.32		
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18	1	2.21						
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
Sample total:	1	2.21	1	0.12	14	2.10	34	0.00
Effort date(s):								
All species total:								

Water	White Lake T03N R07E S12							
Survey	05/21/2007-06/05/2007							
Gear	All Gear combined							
Effort meas.	Various							
Species	Largemouth bass		Longear sunfish		Northern pike		Pumpkinseed	
Legal size (in)	>=14.00		>=6.00		>=24.00		>=6.00	
Avg. length (in)	12.9		2.7		20.7		5.8	
Avg. weight (lb)		1.49		0.01		2.11		0.20
	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.
Total	29	43.25	29	0.41	13	27.43	89	17.46
No. legal	13		0		3		52	
% Legal size	44.83%		0.00%		23.08%		58.43%	
% Total catch	2.75%	14.52%	2.75%	0.14%	1.23%	9.21%	8.43%	5.86%
CPE								
Inch group								
0								
1			2					
2			20	0.2			6	0.06
3			7	0.21			10	0.3
4							7	0.49
5	4	0.3					14	1.84
6							30	6.76
7							21	7.48
8							1	0.53
9	2	0.84			1	0.17		
10	4	2.32						
11	3	2.31						
12	2	2						
13	1	1.27						
14	2	3.17						
15	2	3.9						
16	3	7.14						
17	3	8.58			1	1.13		
18	1	3.4						
19	2	8.02			1	1.58		
20					3	5.56		
21					2	4.3		
22					2	4.96		
23								
24					3	9.73		
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
Sample total:	29	43.25	29	0.41	13	27.43	89	17.46
Effort date(s):								
All species total:								

Water	White Lake T03N R07E S12							
Survey	05/21/2007-06/05/2007							
Gear	All Gear combined							
Effort meas.	Various							
Species	Rock bass		Smallmouth bass		Walleye		Warmouth	
Legal size (in)	>=6.00		>=14.00		>=15.00		>=6.00	
Avg. length (in)	5.7		7.9		19.8		4.3	
Avg. weight (lb)		0.29		0.73		2.55		0.09
	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.
Total	21	6.01	5	3.63	4	10.21	14	1.24
No. legal	9		1		4		4	
% Legal size	42.86%		20.00%		100.00%		28.57%	
% Total catch	1.99%	2.02%	0.47%	1.22%	0.38%	3.43%	1.33%	0.42%
CPE								
Inch group								
0								
1								
2	8	0.08					2	0.02
3	3	0.09	1	0.02			8	0.24
4			1	0.05				
5	1	0.12						
6			2	0.28			3	0.64
7	1	0.31					1	0.34
8	1	0.46						
9	5	3.21						
10	2	1.74						
11								
12								
13								
14								
15								
16								
17								
18			1	3.28	2	4.13		
19								
20					1	2.82		
21					1	3.26		
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
Sample total:	21	6.01	5	3.63	4	10.21	14	1.24
Effort date(s):								
All species total:								

Water	White Lake T03N R07E S12							
Survey	05/21/2007-06/05/2007							
Gear	All Gear combined							
Effort meas.	Various							
Species	Yellow Perch							
Legal size (in)	>=7.00		>=		>=		>=	
Avg. length (in)	4.5		0.0		0.0		0.0	
Avg. weight (lb)		0.04		0.00		0.00		0.00
	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.
Total	3	0.12	0	0.00	0	0.00	0	0.00
No. legal	0		0		0		0	
% Legal size	0.00%							
% Total catch	0.28%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CPE								
Inch group								
0								
1								
2								
3	1	0.02						
4	1	0.03						
5	1	0.07						
6								
7								
8								
9								
10								
11								
12								
13								
14								
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31								
32								
33								
34								
35								
36								
37								
38								
Sample total:	3	0.12	0	0.00	0	0.00	0	0.00
Effort date(s):								
All species total:								

Appendix E
Shorelands Management

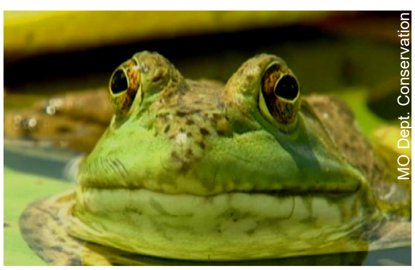
Shoreland Management

A publication of the White Lake Citizens League

Spring 2019

Natural shorelands areas around lakes help to reduce pollution runoff and provide valuable fish and wildlife habitat. As such, natural shorelands are essential to a healthy lake. In a recent U.S. Environmental Protection Agency nation-wide study, loss of natural shoreland was identified as the greatest threat to the nation's lakes. The study found that lakes with poor shoreland habitat were three times more likely to be in poor biological condition. Preserving (or restoring) natural shoreland is one of the most important things we can do to protect the lake.

Due to historical shoreline development patterns, natural shorelands are nearly non-existent on many inland lakes. The challenge and opportunity in the future will be to restore the many ecological benefits of natural shorelands while maintaining full recreational use and enjoyment of our lake. We need to work together to strike a healthy balance.



Seen me lately? Probably not. No plants = no cover = no frogs or other critters.

In addition to providing important environmental benefits, natural shorelands can be beautiful. Recognizing the value of natural shorelands, several states including Minnesota, Wisconsin, Vermont, Maine, and New Hampshire have adopted state-wide shoreland protection regulations. In Michigan, restoration of natural shorelands is fast becoming a priority and several voluntary initiatives are being undertaken to restore natural shorelands. Many lake communities have realized that restoring natural shorelands is a win-win-win scenario: a healthier lake with better water quality; improved fisheries; and better lake living.

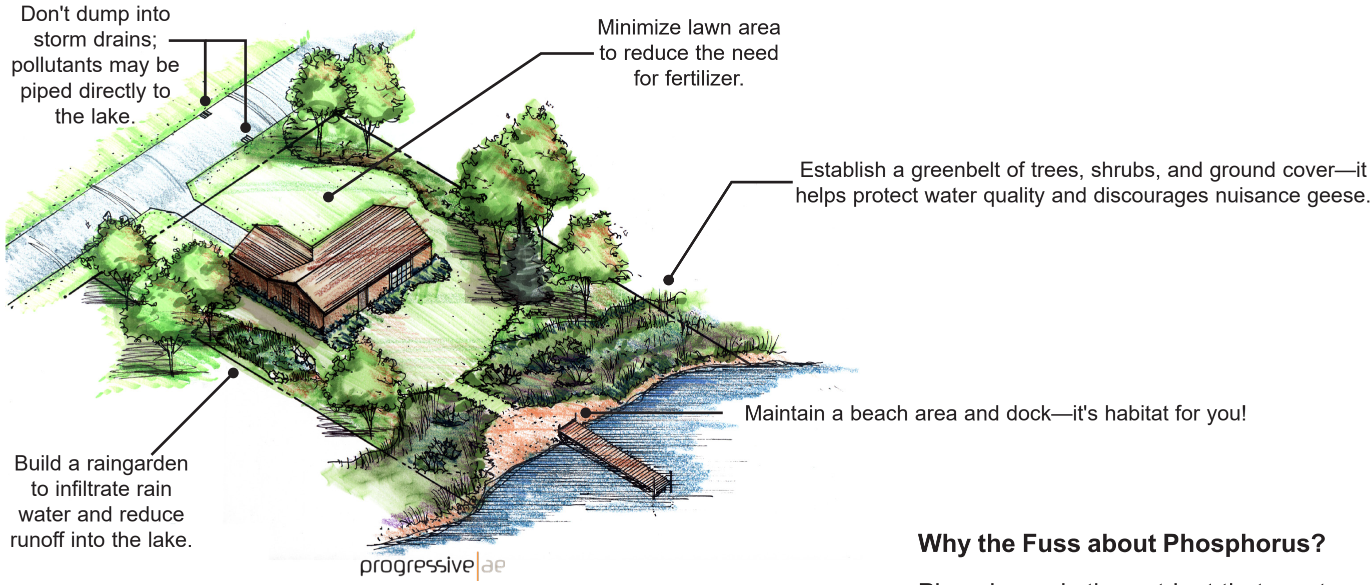
This booklet illustrates several shoreland management practices and provides useful links to shoreland management resources. Please take a minute to review this information and see what practices might work on your property.

Environmental Consultant
Progressive AE

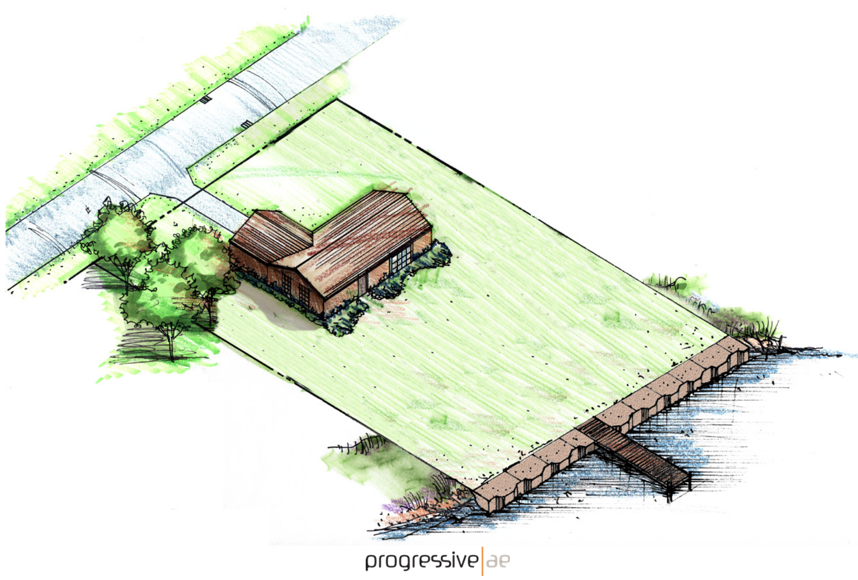
progressive | ae

Shoreland Management

What you can do to enhance your shorelands and protect White Lake.



Failure to preserve some of the natural features of the shoreland will diminish the quality of the lake.



If you think your shoreline can never be restored to a more natural condition, think again! The Michigan Natural Shoreline Partnership is an excellent resource for those wanting to restore natural features on their shorelands. To find out more about the Partnership, visit www.mishorelinepartnership.org.

Why the Fuss about Phosphorus?

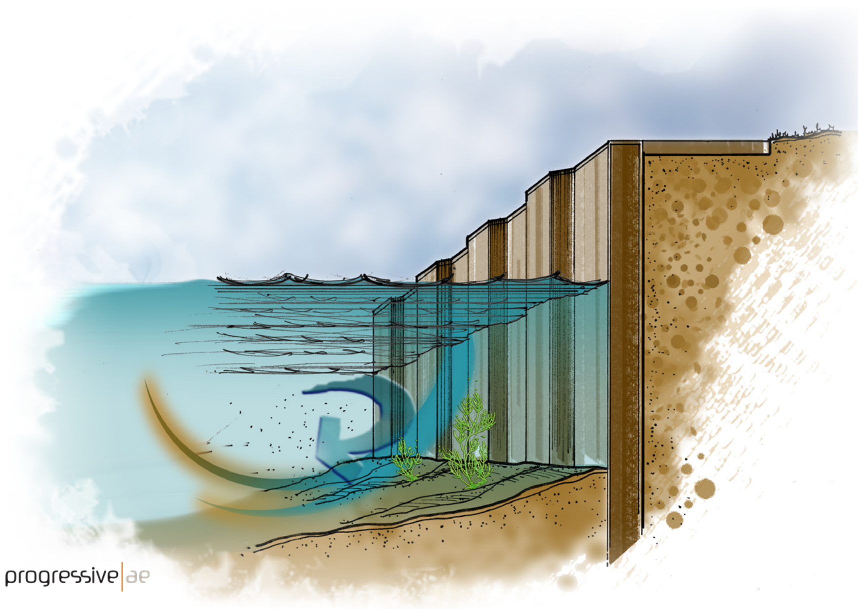
Phosphorus is the nutrient that most often stimulates the excessive growth of aquatic plants and algae, leading to a number of problems collectively known as eutrophication. Once in a lake, a pound of phosphorus can generate hundreds of pounds of aquatic vegetation. Lawn fertilizers are a primary source of phosphorus. Michigan law prohibits the application of lawn fertilizers containing phosphorus unless a soil test documents a phosphorus deficiency or a new lawn is being established.

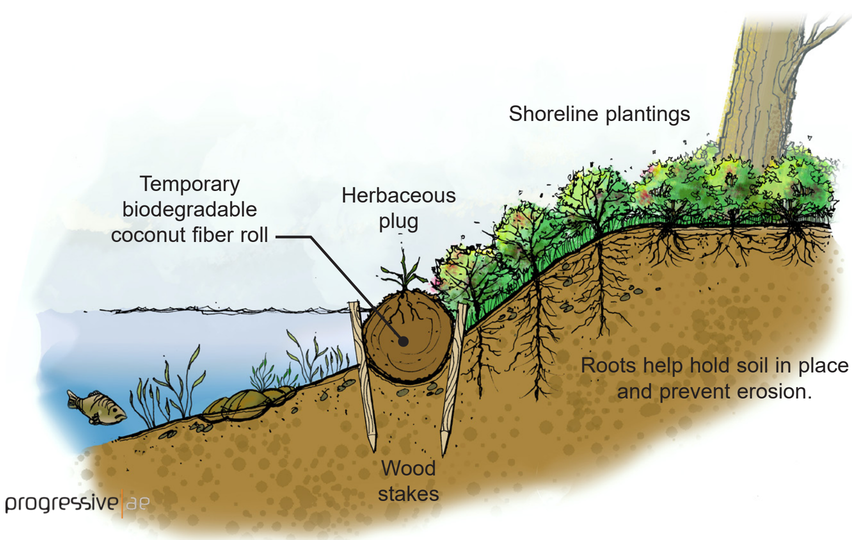
MICHIGAN NATURAL SHORELINE PARTNERSHIP

What's wrong with a seawall?

Most seawalls were built to help prevent erosion and stabilize the shoreline. However, there have been several unintended consequences of seawall construction:

- Seawalls deflect waves and can accelerate erosion at the foot of the seawall and nearby properties that lack seawalls.
- When a wave hits a seawall, its energy is not dissipated. Instead the wave is redirected back to the lake creating rough water conditions.
- Seawalls block the migration of frogs and other animals to shore.
- Some of the problems with seawalls can be lessened by placing large stone in the water at the base of the seawall. Remember, any work below the ordinary high water mark will require a permit from the Michigan Department of Environmental Quality (MDEQ). The MDEQ recently created an expedited permitting process for natural shoreline restoration.
- If you are considering altering or removing your seawall, consider a "bio-engineering" approach in which natural materials are used.

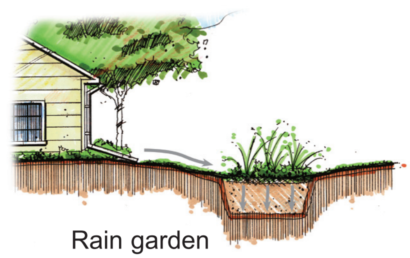




Bio-engineering is a method of stabilizing shorelines with shrubs, trees, and groundcover to prevent erosion and provide fish and wildlife habitat.

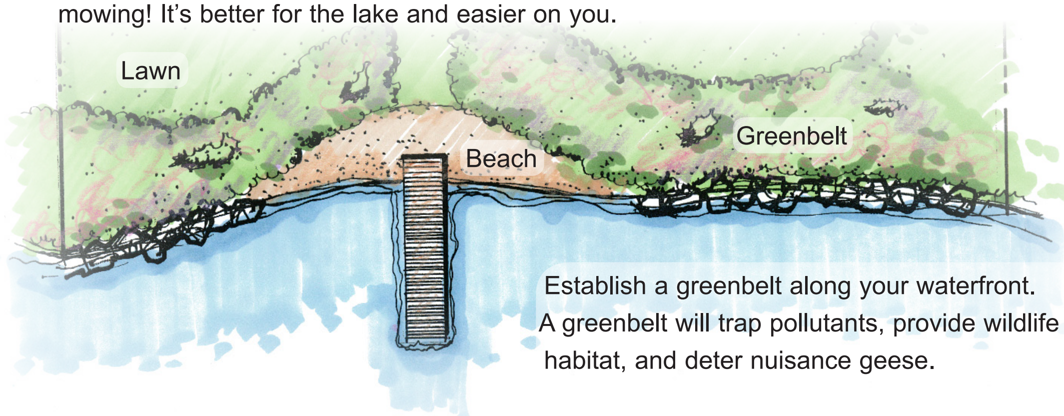
1. Don't use lawn fertilizer that contains phosphorus. If you use a professional lawn care service, insist upon a fertilizer that does not contain phosphorus.
2. Use the minimum amount of fertilizer recommended on the label—more is not necessarily better!
3. Water the lawn sparingly to avoid washing nutrients and sediments into the lake.
4. Don't feed ducks and geese near the lake. Waterfowl droppings are high in nutrients and may cause swimmer's itch.
5. Don't burn leaves and grass clippings near the shoreline. Nutrients concentrate in the ash and can easily wash into the lake.
6. Don't mow to the water's edge. Instead, allow a strip of natural vegetation (i.e., a greenbelt) to become established along your waterfront. A greenbelt will trap pollutants and discourage nuisance geese from frequenting your property. Visit www.shoreline.msu.edu
7. Where possible, promote infiltration of stormwater into the ground. Build a rain garden to capture runoff from driveways and downspouts. Visit www.raingardennetwork.com
8. Don't dump anything in area wetlands. Wetlands are natural purifiers.
9. Collecting roof runoff in rain barrels reduces the amount of water that flows from your property. To find out more, visit epa.gov/soakuptherain/soak-rain-rain-barrels
10. Don't be complacent—our collective actions will make or break the lake!

When buying fertilizer, look at the number in the middle on the label—it should be zero.



Rain garden

Minimize lawn area. Less turf means less fertilizer, less pesticides—and less mowing! It's better for the lake and easier on you.



Establish a greenbelt along your waterfront. A greenbelt will trap pollutants, provide wildlife habitat, and deter nuisance geese.

For more information, vist MichiganLakeInfo.com

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